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DANIEL B. SMITH, *President of the College of Pharmacy.*

Philadelphia, March, 1832.

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A

MANUAL

OF

GENERAL ANATOMY,

CONTAINING

A CONCISE DESCRIPTION OF THE ELEMENTARY TISSUES

OF THE

HUMAN BODY.

FROM THE FRENCH OF

A. L. J. BAYLE AND H. HOLLARD.

BY

S. D. GROSS, M. D.

PHILADELPHIA:

JOHN GRIGG, NO. 9, NORTH FOURTH STREET.

1828.

Eastern District of Pennsylvania, to wit:

BE IT REMEMBERED, that on the twenty-seventh day of September, in the fifty-third year of the Independence of the United States of America, A. D. 1828, J. Grigg of the said district hath deposited in this office the title of a book, the right whereof he claims as proprietor in the words following, to wit:

"A Manual of General Anatomy, Containing a Concise Description of the Elementary Tissues of the Human Body. From the French of A. L. J. Bayle and H. Hollard. By S. D. Gross, M. D."

In conformity to the act of the Congress of the United States, entitled "An act for the encouragement of learning, by securing the copies of maps, charts, and books to the authors and proprietors of such copies during the times therein mentioned;"—And also to the act entitled "An act supplementary to an act entitled 'An act for the encouragement of learning by securing the copies of maps, charts, and books to the authors and proprietors of such copies during the times therein mentioned,' and extending the benefits thereof to the arts of designing, engraving, and etching historical and other prints."

D. CALDWELL.
Clerk of the Eastern District of Pennsylvania.

TO

GEO. M'CLELLAN, M. D.

PROFESSOR OF ANATOMY AND SURGERY

IN THE

JEFFERSON MEDICAL COLLEGE,

Whose great skill and extensive knowledge in the various departments of the Medical Sciences, add lustre to the profession, and whose integrity of principle and private virtues are not less distinguished than his professional attainments, the following pages are inscribed as a testimony of the esteem, the gratitude and respectful attachment of his friend and pupil,

S. D. GROSS.

Philadelphia, August, 1828.

The Reader is requested to correct the following

ERRATA.

Page.	Line.	
2,	30,	*for* lymph, *read* chyle.
9,	1,	*for* spungy, *read* spongy.
17,	5,	*for* anasarca and œdema, *read* œdema and anasarca.
19,	10,	*for* recrementitial, *read* excrementitial.
31,	7,	*for* carachus, *read* urachus.
84,	10,	*for* consists, *read* consist.
86,	11,	*for* desication, *read* desiccation.
120,	24,	*for* vertebra, *read* vertebræ.
163,	28,	*for* on dividing of the ganglia, *read* on division of the ganglia.

PREFACE.

General Anatomy is a science of comparatively modern date; and like every other great and important improvement, it has gradually arrived at its present degree of perfection. To Bichat, no doubt, is due the honour of having first established this branch of anatomy into a science, and the work which he has left us upon this subject, is at once an imperishable monument of his great talents and of his ingenious and profound researches.

Notwithstanding the importance of a thorough knowledge of General Anatomy, it is a fact, that it has received less attention in this country, than perhaps in any other part of the globe to which medical science has hitherto found its way. For the truth of this assertion, we appeal to the candid and high minded student, whether during the course of his attendance upon lectures, he has heard his anatomical professor enter into any minute details on this important branch of his professional studies, or whether he has not merely glanced at it, or perhaps said nothing upon the subject. We shall not stop to inquire into the cause of this neglect; but we fondly anticipate the day when this evil shall be remedied; and ardently hope that the science of general anatomy may soon receive that share of attention from the physicians of this country, which it so justly merits, and which it at present receives in the medical schools of Europe, and particularly in those of France and Germany.

We have been aware that a work on general anatomy is much wanted in this country; and with these impressions we have undertaken the translation of the Manual of MM. Bayle and Hollard; in doing which we have not scrupled to make a few alterations, but the deviations from the original are trifling. If, however, we have failed in some instances, in doing justice to the original, we ask only the indulgence of those who have the liberality and candour to receive with impartiality whatever is intended to facilitate the progress of their studies, while we neither ask nor care for the indulgence or liberality of sentiment of those of an opposite character.

S. D. GROSS.

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INTRODUCTION.

Life is the phenomenon which results from the actions of an assemblage of organs, which are more or less intimately connected together according to the ultimate functions which they are destined to perform. During a long time the study of the organs in relation to their form, their structure and physical characters, and the study of the same parts in relation to their functions, were always combined, and were made the special object of the science of physiology. But in consequence of the progress of our knowledge of organization, the separation of these two kinds of study has become essentially necessary. Anatomy is the science which treats of the conformation, the situation and structure of the organs, while physiology regards in a more especial manner, the functions of the animal economy.

Anatomy is divided into two branches; into special and general anatomy. The former has for its object the particular study of each individual organ enjoying an action peculiar to itself; it describes the physical properties, the form and relative situation, and shows the mutual arrangement of the elementary tissues which contribute to its formation. The latter, of which this work is intended to present a summary, treats of the elementary tissues and organic systems, considered in a general point of view, and abstractedly of the organs which they contribute to form.

The term *tissue* is applied to every species of the animal solids having peculiar and distinctive characters. The tissues are the constituent parts of our organs, or in other

words, their elements. Each tissue, regarded as a whole, is called *system,* in whatever part of the body it is found.

The human body is composed of solids and fluids, the latter of which, form by far the most considerable share. Before we enter upon the examination of the organic systems, it is necessary to say something of those materials which perform a general and important character in the animal economy—a character, which, after having engaged for ages the exclusive attention and study of physicians, was lost sight of by the moderns, who uniformly sought in the solids the seat of every morbid derangement.

Of the Fluids.

It is impossible to determine with any degree of precision, the relative quantity of the solids and fluids: some believe that the latter are to the solids as six to one; others that their relative proportion is as nine to one.

The fluids are contained within the solids, which are more or less penetrated, according to the kind of organ that is examined. Their fluidity is owing more to the vital influence than to the quantity of caloric which they contain. When drawn from the vessels of a living animal, and removed from the heat to which they have been exposed, most of them coagulate.

The animal fluids consist, first, of the fluids which are converted into blood; secondly, of the blood itself, which is the source and reservoir of all the other humours; and, thirdly, of the fluids which are derived from the blood.

Of the Fluids which are converted into blood.

The fluids which are converted into blood are the lymph and the chyle. The lymph is the milk-like fluid which results from the changes which the chymous pulp undergoes in the duodenum. Examined a short time after it has been absorbed by the chyliferous vessels of the intestines, it is slightly coagulable, of a saltish taste, and of a whitish

appearance. In the glands of the mesentery, its characters are sensibly modified; it becomes more coagulable, and presents a reddish tint, which, upon the arrival of the chyle in the thoracic duct, is changed to a beautiful red colour. Examined with the microscope, the chyle is found to consist of a great number of globules and corpuscles which are precisely analogous to those of the blood, with the exception of their colour, which is much fainter.

Lymph is a transparent, viscid and albuminous fluid, whose quantity is much smaller than is commonly supposed. It is contained in the lymphatic vessels, and is mixed with the chyle in the thoracic duct.

Of the Blood.

The blood of a healthy person, is a fluid of a beautful red colour, contained in the cavity of the heart, and blood-vessels, and varying in quantity from ten to twenty-five pounds. When flowing from its vessels in the living animal, it is an unctuous liquid of a peculiar odour and saline taste, of the temperature of 98° of Farenheit's thermometer, and of the specific gravity of 1050.

The microscopic observations of Hewson, Béclard, Prévost and Dumas, tend to prove that the blood, while circulatingin its vessels, is nothing else than the serum, holding in suspension small, regular, and insoluble corpuscles. These are uniformly composed of a central, colourless spheroid, and of a red, semi-transparent envelope.

When the blood has ceased to be under the vital influence, it gradually loses its heat, disengages a considerable quantity of carbonic acid gas, and coagulates. A short time after coagulation, the clot separates into two elements; the solid part is called the crassamentum, the fluid part, the serum of the blood. When the coagulum of the blood is carefully and repeatedly washed in a small stream of water, the colouring matter is gradually disengaged, and a glutinous and fibrous mass remains, which has been termed

fibrin or coagulable lymph. This substance is of a grayish colour, of a firm consistence, and has all the properties of the muscular fibre.

The serum of the blood is of a greenish-yellow colour, and of the average specific gravity of 1030. It is alkaline, and when exposed to a temparature of 160°, it is converted into a white coherent mass, from which a fluid, termed the serosity, may be obtained by pressure. According to the analysis of Dr. Marcet, the serum conists of the following ingredients:—

Water, ...	900.00
Albumen, ...	86.80
Muriate of potash and soda, .	6.60
Muco extractive matter, . .	4.00
Sub-carbonate of soda, . .	1.65
Sulphate of potash, . . .	0.35
Earthy phosphates, . . .	0.60
	1000.00

The colouring matter of the blood results from a mixture of the disengaged red matter and the serum. It is insoluble in water, and its chemical properties show that it is a peculiar animal principle united with a per-oxide of iron.*

Besides these, the blood contains an unctuous substance, and a halitus which is seen to rise from the surface of blood recently drawn, upon the same principle that a sensible evaporation takes place from the surface of other liquids whose temperature had been considerably elevated.

* According to the analyses of Berzelius, the colouring matter of the blood, after being incinerated, affords the following residue:—Oxide of iron, 50.0; sub-phosphate of iron, 7.5; phosphate of lime with a very small proportion of magnesia, 6.0; pure lime, 20.0; carbonic acid gas and loss, 16.5.—100.0. (*a*)—S. D. G.

(*a*) Thomas's System of Chemistry, Vol. IV.

During life the blood is constantly subject to the impulse of the heart, which, with the aid of other causes, produces a continual circulation in its cavities, in the arteries and the veins. In the course which it traverses, the blood undergoes continual changes in its composition and nature; —changes which have for their ultimate object the nourishment of the organs. It is renewed and repaired by the chyle, which is carried to it by the thoracic duct; it receives the refuse of all the absorbents, as well as the molecules which have ceased to form part of the body; it is vivified during the act of respiration, by which it loses a considerable quantity of serum and of carbon, absorbs oxigen, and changes from a dark red colour to a beautiful vermilion: thus restored, it becomes the source of all the secretions and the vital principle of all the tissues with which it is incorporated.

3. *Of the Fluids which are derived from the blood.*

All the molecules which enter into the composition of our organs, or are thrown off, are derived from the blood, and are at first in a state of fluidity. These fluids may be divided into three classes:—

1. Into those which are immediately subservient to assimilation, to the growth, and reparation of our organs, or in other words, into those fluids which are especially nutritive.

2. Into those which are deposited into certain cavities, and in the intervals of the organs, as the fat, the serum, and synovia, as well as those which are exhaled on the surface of the body, as the cutaneous and pulmonary perspirations.

3. Into those which are the production of a glandular elaboration. They are, the mucus, the sebaceous matter, the lacrymal fluid, the salivary fluid, the bile, the pancreatic fluid, the milk, the semen and urine.

Of the Tissues and Organic Systems.

It is difficult to determine the number of the elementary tissues of the body, because some of them are only modifications of each other, and also on account of the great discrepancy in the opinions of authors in regard to this subject. Some (Mascagni) regard the solids as being composed entirely of vessels; others as formed of cellular tissue. Haller has admitted the existence of three kinds of primary tissues in the composition of our organs, viz., the cellular, the muscular, and the nervous. To this, M. Chaussier has added the *albugineous fibre* which enters into the composition of the ligaments. M. Richerand also admits these four tissues, besides the horny substance which constitutes the basis of the epidermis, the nails, and the hair. Bichat divides all the tissues into twenty-one, three of which are the *generators* of the rest. These tissues are:—the cellular, nervous of animal life, nervous of organic life, arterial, venous, exhalent, absorbent, osseous, medullary, cartilaginous, fibrous, fibro-cartilaginous, muscular of animal life, muscular of organic life, mucous, serous, synovial, glandular, dermoid, epidermoid and pilous. Béclard, including several of the preceding systems under the same denomination, after Meckel, has described successively the cellular tissue, the serous membranes, the tegumentary membranes, the vascular system, the glands, the ligamentous tissue, the cartilages, the osseous tissue, and the muscular and the nervous systems. As regards ourselves, in admitting the systems established by M. Meckel,* we have

* Meckel recognises ten elementary tissues:—the *mucous, serous, vascular, nervous, osseous, cartilaginous, fibrous, fibro-cartilaginous, muscular*, and *dermoid.*

M. Adelon divides the textures or systems into twelve classes:—the *cellular, vascular, nervous, osseous, cartilaginous, fibrous, muscular, erectile, mucous, serous, corneous, and parenchematous.*

Professor Mayer admits only seven systems:—*the lamellated tissue, the*

adopted an arrangement somewhat different from those that have been hitherto followed: we have endeavoured to classify the tissues in a manner expressive of their progressive complication. Thus we have placed after the cellular and vascular tissues, all those, which, being only modifications of the first, present nothing in their organization but vessels, and appear to be destitute of nerves:—these are the serous, the fibrous, the cartilaginous, and osseous systems. Then commences a second series at the head of which are the nervous system, and those which are composed of the tissues that are formed of a cellular net-work of vessels and nerves; viz., the tegumentary, the glandular and muscular tissues.

Before we conclude, it is necessary to observe that this work, which we had intended to write together, is almost entirely the labour of M. Hollard, the health of M. Bayle having permitted him to take but a feeble part in it.

cellulo-fibrous tissue, the fibrous system, the cartilaginous tissue, the osseous tissue, the muscular fibre, and the nervous tissue. S. D. G.

MANUAL

OF

GENERAL ANATOMY.

CHAPTER I.

CELLULAR SYSTEM.

SECTION I.

Cellular Tissue, properly so called.

Synonyma: Cellular substance, body, membrane, organ, mucous tissue, glutinous tissue, areolar tissue, reticular tissue, laminar tissue, filamentous tissue.

Definition. The term cellular is applied to a soft spungy tissue, which is spread throughout the whole body, connects the various organs together, surrounds and insinuates itself between them, and enters into their substance in order to contribute to their structure.

Division. This tissue forms a complete whole; but in consequence of the different relations, and of the more or less intimate connexions which subsist between it and the various organs of the body, it is necessary to distinguish it into *common* and *special;* and all that we have to observe respecting the manner in which the cellular tissue is arranged in the animal economy, being applicable to these two divisions, we shall commence with the description of the first.

1. *Common cellular tissue.* The common cellular tissue regarded as a whole, presents the general configura-

tion of the body, forms a complete subcutaneous envelope, and has all the organs, with the exception of the teguments, embedded in its mass. Its quantity is not every where the same: proceeding from the exterior to the interior parts of the body, we find that it abounds under the skin, particularly in the face, in the anterior and lateral parts of the neck, the parietes of the thorax and abdomen, the scrotum, in the vicinity of the large joints, and in those places where extensive flexion is performed, especially in the axillæ and groins; between the laminæ of the mediastinum, around the large vessels, in the inferior part of the cavity of the abdomen, particularly around the kidneys, between the folds of the peritoneum, but still more around the pelvic viscera;—an arrangement favourable to the changes of volume accompanying the exercise of their functions. This tissue, on the other hand, is thin on the mesian line of the body (except in the neck,) under the teguments of the head, in the cavity of the cranium, and in the vertebral canal, especially between the dura mater and bony case.

The common cellular tissue which is spread over the exterior parts of the body, communicates with that of the interior by all the interstices which are left between the different organs, but in a still more remarkable manner by the orifices and inter-organic spaces which give passage to vessels and nerves. This kind of communication takes place in the holes of the cranium and vertebral column, and in the cavity of the thorax, where the cellular tissue of the neck and arms enters in accompanying the vascular trunks and nerves which enter and pass out at the superior part of that cavity. From the thorax it passes into the cavity of the abdomen between the pillars of the diaphragm along with the œsophagus, the aorta and vena cava; and at the crural arch and inguinal ring, it communicates with the cellular tissue of the inferior extremities.

2. *Special cellular tissue.* Considered in its more direct relations with the organs, we observe, that the cellu-

lar tissue surrounds and envelops them with a particular covering, which forms, according to the happy expression of Bordeu, an atmosphere of insulation, that enters every where into their intimate structure.

1. *The cellular tissue which covers our organs* is formed by a condensation of the common cellular tissue, of which it is a continuation. Its thickness varies in the different regions of the body; it is more considerable around the parts which perform extensive motions, and those which are not insulated by a membranous envelope, as the thyroid gland, the kidneys, &c. The skin, the mucous and serous membranes, the vessels and excretory ducts are lined only at their adherent surfaces, by a layer of cellular tissue.

a. Under the skin this layer is not every where equally dense and compact: it is most so in the palm of the hand, the sole of the foot, around the annular ligaments, and on the mesian line of the body; on the other hand, its laxity is remarkable in the eye-lids and scrotum.

b. The submucous layer is generally more dense than the preceding; so that it seldom contains any collections of serum: this character is indispensably necessary, in order that the muscular fibres which are inserted into it may have a point of attachment.

c. The serous membranes, intended, mostly, to facilitate more or less extensive gliding movements, are furnished, at their adherent surface, with a loose cellualar tissue, which is particularly conspicuous in the abdomen: notwithstanding, some parts of the pericardium, the greatest part of the synovial and arachnoid membranes, adhere intimately to their respective organs.

d. It forms layers that envelop the blood vessels, lymphatics and excretory ducts: those around the arteries are extremely compact, condensed, and resisting, in order to preserve their cylindrical form when they are insulated; those of the veins and lymphatics are less thick and compact;

while those of the excretory ducts are thicker than those of the veins and thinner than those of the arteries.

The organs, which are composed of a substratum of several membranes, present a more or less compact cellular tissue between them, which belongs in part to the submucous and subserous layers in the intestinal canal and in a portion of the bladder, and which, considered in relation to their tunics, enjoys the character of the exterior cellular tissue, notwithstanding it must be regarded as interior, when we take into consideration the organs with which it is connected. It forms in fact a transition between the subdivision of which we have just spoken and the following.

2. The cellular tissue, after having covered the organs, enters every where into their structure, and envelops the most minute parts of their substance. Thus, each fasciculus, every muscular fibre and fibrilla, the glands and every glandular particle, are surrounded by a pouch or cellular sheath. This pouch is more delicate in proportion as the organic particle which it surrounds is more minute. A cellular tissue, more lax than that which forms these pouches, separates them from each other: in short, the interior cellular tissue is destined to the same uses, in relation to its parts, that the common cellular tissue of which we have just spoken, performs for the organs. We perceive but little cellular tissue in the brain and spinal marrow, in the bones and ligaments; and it can be seen in the cartilages only after a long and tedious maceration.

Structure. What is the interior conformation of the cellular tissue? If we examine a portion which has neither been stretched nor distended by fluids, it will present, either the aspect of a homogeneous, semi-transparent substance, or an appearance of a lamellated and filamentous texture; the first form appertains particularly to the special cellular tissue, the second to the common tissue: moreover, if we separate two bodies that have been united by cellular

tissue, we shall observe that the latter is composed: 1st, Of transparent laminæ, especially in those regions where it is of a loose texture, as in the eye-lids and scrotum; and 2d, Of filaments, which are either single, or interlaced with these laminæ. Both are soft and whitish, and may be greatly distended before they break. If air or water be introduced into this tissue, these fluids will permeate it with the greatest facility and occupy the irregular cells, which are formed by the interlacement of the laminæ and filaments, to which we have just alluded. The existence of these cells can be rendered evident by freezing an infiltrated limb; numerous little icicles will be formed, and show by their form that of the cells which they occupied. From these facts Haller, Bichat, Béclard and M. de Blainville, of the present day, as well as most of the English and Italian anatomists, have concluded that the cellular tissue has a lamellated and filamentous texture from which resulted the existence of irregular permanent cells, varying in figure, and communicating with each other. Bordeu, notwithstanding, has asserted that the tissue, now under consideration, was merely a homogeneous substance, destitute of form, and of a viscous, gelatinous nature. Adopting this method of observing, Wolff, and more recently Rudolphi, Heusinger, J. F. Meckel, and others, have maintained that the laminæ, filaments and cells of the cellular tissue do not naturally exist, but that they are produced by distention, and that similar phenomena may be produced by distending a mass of mucus or glue: consequently they have described the cellular tissue under the name of the *mucous tissue.** In answer to these assertions we may observe: first, that the texture of the cellular tissue is evident in a number of places, without previous distention;† secondly,

* May we call this tissue an amorphous and perfectly homogeneous substance, as these authors conceive it to be?

† Meckel appears to acknowledge this fact, by saying, that the opinion opposed to his is at least too common.

that its permeability is too remarkable to belong to a homogeneous and viscous substance,* and that, performing the office of a spongy and cellular tissue, it ought, thus far, to be regarded as such.

Our ideas of the nature of cellular tissue are vague and hypothetical. According to Meckel, it consists of *a coagulable fluid in a state of coagulation.* Ruisch and Mascagni assert, that it is composed of vessels; Fontana, of tortuous cylinders. Be this as it may be, it is certain that it is supplied with a great number of capillary vessels, which it furnishes with coats, and which carry red blood only when they are in a state of inflammation

Differences according to age. The cellular tissue, the basis of all the others, is represented in the first periods of gestation, by a viscous substance, in the midst of which the organs are developed—a substance, which diminishes, acquires consistence, and after having passed from a state of mucus and gelatine, at length assumes the texture which we have already described. Bichat supposed that the filaments and layers existed in the first period of the embryon, and could not be perceived on account of their tenuity and the quantity of the fluid which filled their interstices. As the organs are developed, the mass of the common cellular tissue gradually diminishes; notwithstanding, it continues to be predominant for many years after birth. The same thing takes place during a great part of the life of the female; hence, that rotundity of form common to her and the infant. In the latter, the cellular tissue is more delicate, its serum more abundant, and its vital energy more conspicuous than at any subsequent period of life. In the adult, it becomes more firm and condensed, is less humid, forms layers of a more compact texture and renders the subcutaneous organs more prominent. In old age, it is dry,

* In consequence of wounds of the lungs, air sometimes penetrates into the cellular tissue with a promptitude and facility that could not be explained without admitting the pre-existence of cells.

less elastic, and somewhat withered;—a circumstance to which must be attributed in part, the wrinkles under the skin of old people.

Physical and chemical properties. The cellular tissue, almost colourless when distended, presents a grayish white appearance whenever it forms a thin layer; its cohesion, which is in direct ratio with its density, forms a medium between that of mucilage and the fibrous tissues. It is eminently elastic.

Exposed to putrefaction, the cellular tissue yields to it less readily than many other animal substances; it resists for a long time the action of the gastric juices, and of ebullition; and months are scarcely sufficient for its maceration. It is composed principally of gelatine, with a small quantity of fibrin and earthy salts.

Vital properties. In the healthy state, the sensibility of this tissue is very obscure; it evidently possesses some degree of contractility of texture, which is more conspicuous in youth than old age.

Functions. The common cellular tissue serves to connect the organs together, and by its pliancy and elasticity, to facilitate their motions. It serves, more immediately, to form around them a kind of atmosphere, which contributes to protect them from the diseases of the neighbouring parts; and, in furnishing an envelope for their most minute corpuscles, to determine their extent and configuration. This tissue is the seat of a serous exhalation,* principally composed of albumen, which moistens it continually, and serves to facilitate the motions of the contiguous parts. It is small in quantity, and when the tissue which it lubricates is laid bare in a living animal, it appears under the form of vapour: it is continually furnished by the exhalents and taken up by the absorbents. We may observe, that its

* Many anatomists suppose that this secretion is produced by an elaborating process of the cellular tissue.

quantity is in an inverse ratio to that of the fat in the different regions.*

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The cellular tissue is the basis of many adventitious productions, as polypi, fungi, cicatrices, &c. &c. which prove its great plastic energy.

When a re-union can not be immediately effected, after a solution of continuity, the denuded surface puts on an inflamed appearance, and soon after becomes covered with red granules, improperly called fleshy granulations, since they result from a development of the inflamed cellular tissue, and not, as was asserted by Galen, from a reproduction of *flesh*. As these granulations grow, they secrete purulent matter, become uneven at their surface, and contract; while this is taking place, the secreted matter becomes thicker, and is at length organized under the form of a thin pellicle, which is continued with the neighbouring epidermis: under this, the depressed granulations are converted into a wrinkled tissue, which is analogous to the chorion of the skin, and which gradually loses its reddish tint, and becomes whiter than the original skin. This forms what is called a *cicatrix*. These phenomena take place from the circumference towards the centre of the wound, whose edges approximate, from this last point, in consequence of the contractions of the granulations. From this it results that the cicatrices occupy less space than the original wound. After the immediate re-union of a solution of continuity, there are neither granulations nor pus; the cicatrix being formed by an effusion of adhesive matter upon the surface of the wound, which becomes at first more

* The fatty fluid placed hitherto upon the same line as the serosity in the history of the cellular tissue, appears to be deposited in a particular tissue which has been described separately, as a modification of the cellular tissue: as this distinction appears to be well founded, we shall describe the adipose or fatty tissue under a distinct section.

dense than the cellular tissue, but is finally confounded with it.

The cellular tissue is frequently distended by collections of the serum, which lubricates it. When this affection is local, it is termed *anasarca*, and *œdema*, when it extends throughout the whole system. It is most frequently connected with chronic diseases of one or more of the principal viscera, or with an obstruction of the circulation: the most dependent parts of the body are the ordinary seat of œdema. When serum is extravasated into the cells of the cellular tissue, it leaves the part where it is found as soon as their position is rendered less dependent; another proof of the great permeability of this tissue and of the pre-existence of its cells. Air sometimes penetrates into this tissue, in consequence of wounds of the thorax, &c.; gas also is disengaged in certain cases; this kind of infiltration is called *emphysema*. The cellular tissue is frequently the seat of *phlegmonous inflammation*, which may be dispersed by resolution: when acute, it often terminates in suppuration, that is, by the secretion of a white, inodorous, cream-like fluid, (pus) which, being at first disseminated through the cells in which it is formed, collects into an abscess, and has a tendency to travel towards the surface; which is readily effected when the inflammation has some degree of intensity and the situation of the purulent abscess is not obstructed: under these circumstances portions of cellular tissue are often discharged with the pus. If the disease is somewhat slow in its progress, the parietes of the abscess become lined by a membrane, resulting from the condensation of the cellular tissue, and which has some analogy to the mucous membranes. When the pus is evacuated, these parietes approximate and the cavity of the abscess is obliterated; or if the matter continues to discharge, the course which it takes to arrive at the external surface, is also lined by a mucous membrane, and is thus converted into a *fistula*. In some instances, the abscesses are intersected by bands and

partitions, which are nothing more than the remains of the cellular tissue which occupied their cavity. The gangrenous eschars, which often result from acute phlegmonous inflammation, are soft and grayish, and are called *ventriculi furunculorum.* Those which are formed in some phlegmonous tumours, as furunculus and anthrax, are attributed to a kind of strangulation of the inflamed cellular tissue. Inflammation, after it has passed into the chronic state, often deposits into the cells of the cellular tissue, a kind of concrete matter, which gives rise to the alteration called *white induration:* this constitutes the granulations which are often exhibited in the subserous and submucous cellular layers. The elephantiasis of Barbadoes consists in a morbid derangement of this kind.

The induration of newly formed cellular tissue, which M. Chaussier has called *scleremus*, is a disease almost exclusively confined to infants, and is characterized by a considerable degree of firmness and consistency of this tissue, especially of the subcutaneous: incisions made into it produce a discharge of a yellowish fluid, which, according to Meckel, consists of a mixture of fat and serum. By Andry this disease is attributed to a suppression of the cutaneous perspiration; by others, to an effect of syphilitic virus. According to the researches of M. Breschet, it is attended with an opening of the foramen of Botal, and consequently by a very evident imperfection in the function of respiration.

When foreign bodies are introduced into the cellular system, they cause inflammation in the contiguous parts, and are most frequently discharged by suppuration; though sometimes they penetrate to a considerable distance: introduced into the alimentary canal, they often pierce its coats, and are conveyed through the different regions of the body, without occasioning any serious mischief.* The cellular tis-

* A case of this kind occurred in a woman who suffered from mania, in consequence of swallowing needles. She died several years after at

sue is sometimes condensed around them and forms a membranous covering or *cyst* (v. Serous System.) The blood, the product of the secretions and the excrements are sometimes extravasated into this tissue and act as foreign bodies: the blood, at first diffused through the cells of the cellular tissue, constitutes what is called *ecchymosis*, and is often brought to a focus before it can be absorbed: hence, it is converted into a coagulum, which, being enveloped in a serous cyst, is soon after more or less readily absorbed. When the recrementitial secretions are extravasated, they readily enter the circulation; and their presence in the cellular tissue often brings on the most fatal inflammations.

The cellular tissue is sometimes the seat of organized beings, such as hydatids, &c.; the filaria dracunculus of Bremser, and the furia infernalis enter it by piercing the skin.

Bibliography.

Th. de Bordeu. Recherches sur le tissue muqueux ou organe cellulaire, etc. Paris, 1767—1791, et dans les Œuvres complètes publiées par le chevalier Richerand. Paris, 1818.

Haller. Elem. phys. corp. hum., t. 1, p. 9. Lausanne, 1787.

X. Bichat. Anatomie générale, tome I, page 100. Ed. de Béclard. Paris, 1821.

Dr. Hayward's Trans. of the same, vol. I, page 87. Boston, 1822.

P. A. Béclard. Elémens d'anatomie générale, 1 vol. in 8. Paris, 1823, p. 133.

J. Fr. Meckel. Handbuch der menschlichen anatomie, c'est-à-dire, Manual d'anatomie humaine, traduit en français sous le titre de Manuel d'anatomie générale, descriptive et pathologique; par MM. Jourdan et Breschet. Paris, 1825, tome I, page 103.

the Hospital of St. Louis, and upon *post mortem* examination, several hundred of these small instruments were found in the cellular tissue of the different parts of the body.

SECTION 2.

Adipose Tissue.

Synononyma: Cellulo-fatty tissue, fatty membrane, web (toile,) adipose tunic.

The existence of the vesicular tissue into which the fat is deposited, has not been acknowledged by all anatomists. Malpighi, Morgagni, and particularly Mr. W. Hunter, and more recently, Proschaska, Mascagni, MM. Chaussier, and Béclard, have described this tissue as distinct from the preceding; but Bichat, adopting the ideas of Haller, asserted that the fat was exhaled and deposited like the serum into the areolae of the cellular tissue. In our day, J. F. Meckel has described the fatty fluid as contained in small rounded, irregular vesicles, formed evidently by a kind of *gluten*, which, according to him, constitutes the cellular tissue. The facts upon which the distinction of this and the adipose tissue rest, re-established lately again by Béclard, have appeared sufficiently conclusive to justify us in describing this tissue under a distinct section.

Definition. The adipose tissue consists of small, microscopic vesicles joined together in more or less considerable masses and filled with fat.

Situation. The adipose tissue abounds exteriorly under the skin of the face, the neck, the anterior parts of the thorax, the abdomen, the nates, the palms of the hand and the soles of the feet, and in the great interstices between the muscles. It is to the accumulation of a great quantity of this tissue that is to be attributed the enormous development of the nates of the Hottentot women, of the tail of the Barbary sheep, and the prominences on the backs of some animals, that, for instance, of the camel. Interiorly, the adipose tissue occurs chiefly around the great vessels, on the surface of the heart, around the kidneys, between

the folds of the mesentery and the omentum. It exists moreover under the denomination of the *medullary substance,* in the bones where it occupies the cells of the spongy and reticular substance, the microscopic interstices of the compact substance and the medullary canal of the long bones: here the adipose vesicles are deposited into the cells of a cellulo-vascular membrane, of which we shall speak more particularly in the history of the osseous system. The interior of the cranium, the globe of the eye, the eye-lids, the penis and the scrotum, the submucous cellular tissue, the lungs, &c. are in general destitute of fat.* In persons of ordinary plumpness, the fat is generally wanting in those organs where its presence would interfere with the exercise of their functions.

Differences of situation and quantity, according to age and sex.—It is not until about the fifth month after conception, that the fœtus presents some insulated adipose vesicles, and then only under the skin. After birth, it becomes more abundant, is seen in the more deep seated parts, and finally in the visceral cavities. Its quantity is much greater in adult age, than in the subsequent periods of life, and in woman than in man. In old age, it occurs almost exclusively around the viscera of the thorax and the abdomen.

Form. The adipose tissue is sometimes seen under the form of considerable laminæ, as under the skin; sometimes, under that of pelatons, as in the orbits; and at others, under that of bands, as in the epiploons, &c.

Structure. In examining the texture of a portion of adi-

* "If the cellular membrane," says Dr. W. Hunter, "had been adipose in the eye-lids, fat people must have been blind; if in the substance of the lungs, they must have been suffocated. Had it been adipose within the skull, fat people would have been as liable to apoplexies as to ruptures; and if it had not been reticular in the *penis,* fat men would have been much incommoded." Med. Obs. and Inq. v. ii. p. 31. London, 1762.—S. D. G.

pose tissue, it will appear at first sight to be composed of small, oblong masses which result from an assemblage of milliary granules, formed by the agglomeration of a multitude of small round and transparent vesicles, which are somewhat compressed and visible only by the aid of the microscope. The coats of these vesicles, which probably result from a modification of the cellular tissue, are indistinct, yet their existence can not be doubted for the following reasons; 1st, When a portion of adipose tissue is exposed to a temperature capable of melting the fat which it contains, it does not run out, which would take place were the fat not confined within the cells of the cellular tissue. 2d, Although fluid during life it never gravitates, however abundant it may be, toward the more dependant organs, and 3d, it is not like the cellular tissue, spread throughout the whole body, a fact, which would at least indicate some difference of organization. The adipose vesicles are connected together by very fine cellular tissue, and are supplied with blood vessels that may be readily injected. These ramify at first between the small oblong masses, forming there a kind of net-work which sends to each grain a pedicle composed of an artery and a vein, whose ramifications are distributed, like so many smaller pedicles, to each vesicle in which they appear to terminate. There is but little known with respect to the lymphatic vessels of the adipose tissue, and we are yet entirely ignorant whether it receives any nerves.

Physical and chemical properties. The extreme tenuity of the adipose vesicles is the reason that we know nothing of its physical and chemical properties, except those which result from the presence of the fat contained in the adipose tissue.

Vital properties. In the healthy state, the adipose tissue, is entirely destitute of sensibility, and can not be distinguished, even when in a state of inflammation, from that

of the surrounding cellular tissue. Its contractility is very obscure, but it probably participates in that of the preceding tissue.

Functions. The adipose vesicles serve as a reservoir for the fat, which is fluid during life, and varies in colour, consistence and odour in the different kinds of animals. Human fat is an inodorous substance, of a yellowish colour, of a faint sweetish taste, specifically lighter than water, and fusible at a temperature of 15° cent.* It is insoluble in water, and less soluble in cold than boiling alcohol. At an elevated temperature it is decomposed, and affords hydrogen, oxigen and carbon in various degrees of combination. Its combination with the oxigen of the air gives rise to the sebacic acid. By distillation, it yields celtic acid and a considerable quantity of olefiant gas; and by treating it with the alkalies we obtain the margaritic and oleic acids and the *sweet principle*, (Chevreul.) These last products do not exist naturally, but are the results of new combinations. The experiments of M. Chevreul have shown, that the fat contains two proximate principles, to which he has given the names of *elaine* and *stearine*; the former, soluble in alcohol, fluid at 7° cent. the latter less soluble in alcohol and fluid at a little below 38° cent. The degree of fusibility of every kind of fat is in proportion to the relative quantity in which these two principles are combined.

Various are the hypotheses that have been advanced respecting the manner in which the fat is secreted, and the organic agents upon which it depends. Malpighi believed for a short time, that the vessels of the adipose tissue were accompanied by a small secretory apparatus; but this great anatomist soon abandoned an idea which was utterly destitute of foundation, and which has since given way to others. Riegel asserted that the glands, and particularly the capsulæ renales, were the secretory organs of the fat. Haller supposed that it circulated with the blood; that it floated

* The harder varieties of fat fuse at about 120° Fah.—S. D. G.

upon its surface on account of its specific levity, and escaped through the coats of the vessels; but the most commonly received opinion of the present day, is, that the fat is exhaled from the parietes of the adipose vesicles. This exhalation is sometimes remarkably abundant, especially after protracted abstinence; it is also favoured by sedentary habits, a farinaceous diet and castration. It is here, as every where else, continually counterbalanced by absorption, which frequently exceeds it, particularly in some of the chronic diseases of the principal viscera, in cases of protracted or profuse suppuration, diarrhœa, and some other affections.

The fat appears to be useful in the animal economy, principally by protecting certain parts from the inconveniencies of habitual pressure to which some of them are exposed; such is its use in the soles of the feet, the nates and some other parts. As a bad conductor of caloric, it contributes in some degree to the preservation of that of the body; but its most important office appears to be nutrition, and it may be regarded, if we may be allowed the expression, as aliment in reserve. Examples of this kind are furnished us in hybernating animals. The fat in the bones appears to answer no other purpose than that of the other organs. It was falsely asserted by Haller that it renders the bones less brittle, that it was subservient to their consolidation after fractures, to their nutrition, &c. &c.

Pathological Anatomy.

Obesity, or *polysarcia*, as it is technically called, results from the excessive development of the adipose tissue, and may be regarded as a morbid derangement which impedes the functions of the other organs. When this extraordinary growth is local it is termed *lipoma*. It is often surrounded by a kind of cyst, and generally presents one or more peduncles. Tumours of this description have been seen that have weighed from thirty to forty pounds. They

are all of an irregular spheroidal figure, and are most commonly seated beneath the skin; sometimes, however, they are found in the cavities of the thorax and the abdomen, particularly in the omentum: when they pass out through the inguinal ring, &c. they are called fatty herniæ. Inflammation of lipomatous tumours and of the cellular tissue in general, frequently terminates in gangrene: this morbid state, also, may bring on schirrous and carcinomatous affections. The adipose tissue is often developed in the ovaries, in the submucous cellular tissue, and in other parts where it is seldom found in the healthy state. The muscles and some other organs are subject to fatty productions, which according to Béclard belong only to the former. Of these we shall speak in the history of those organs in which they are developed.—Traumatic inflammation of the adipose tissue produces an evacuation of the vesicles and an effusion of the fat upon the surface of the wound, which is soon covered with cellulo-vascular granulations, and is cicatrized in the same manner as we pointed out in the preceding section.

In the infiltrations of the cellular tissue, the serum is extravasated between the granules and the adipose vesicles, so as to separate them from each other, and to render them very distinct.

Bibliography.

Malpighi. De omento, pinguedine, etc., in Epist. anat. London, 1686, p. 33.

W. Hunter. Remarks on the cellular membrane, etc., in Medic. Obs. and Inq. vol. 2. p. 26. London, 1762.

Béclard. Op. Cit. p. 156.

Chevreul, dans les Annales de Chimie, tome xciv, et les Annales de chimie et de physique, tomes II—VII.

J. A. Sayssi. Secherces expérimentales anatomiques, chimiques, etc., sur la physiologie des animaux mammifères hibernas. Paris, 1808.

CHAPTER II.

VASCULAR SYSTEM.

SECTION 1.

General Observations.

Definition.—The vascular system is composed of an assemblage of membranous tubes or vessels, which are united together so as to present an arborescent arrangement, and are traversed by the fluids which are subservient to nutrition and secretion.

Division.—This system presents three orders of vessels: two convey the blood, and are called arteries and veins; the third comprehends the lymphatic vessels, which carry to them the lymph and chyle, white fluids, the first of which is derived from all the organs, and the second, the product of digestion, is absorbed on the internal surface of the intestines.

Considered in their relations with the heart and the nature of the blood which traverses them, the arteries and veins have been distinguished into those of the pulmonary and those of the general system; but Bichat, struck with the analogy of their functions rather than their anatomical characters, united the vessels which correspond to the same lateral halves of the heart, and obtained the most beautiful results from this division of the sanguineous system into the circulation of red and that of black blood.

General conformation.—The three divisions of the vascular system form an uninterrupted whole, which is called

the *circulatory apparatus*, because its arrangement is such, that the fluids which traverse it, return to the centre where they began their circuit: let us give a general idea of it.

An artery, called the aorta, arises from the left ventricle of the heart, and carries, by its numerous ramifications, the red arterial blood to every part of the body; hence, arise a multitude of small veins which are continuous with the minute extremities of the arteries, and which, uniting successively, terminate, after having received the lymphatic vessels, by the two venæ cavæ and coronary vein, which pour the dark venous blood into the right auricle of the heart. From the right ventricle of the heart originates the pulmonary artery, whose divisions, multiplied ad infinitum, distribute this black blood through the lungs, where, by the act of inspiration, it is converted into a beautiful red colour, as it passes from the minute arterial extremities into those of the venous: these last form, by their successive junctions, small ramifications, then branches, and terminates by the four pulmonary veins, in the left auricle of the heart.

We have already said, that the heart is the point of union of the great vascular trunks: in proportion as these recede from their origin, they divide into branches, these branches into smaller ones, and these progressively into more and more minute ramifications. All the vessels are of a cylindrical form, and preserve a uniform diameter from the place of their origin to that in which they ramify. This, for instance, is the case with the spermatic artery, which traverses a long course without changing its dimensions. If any of the smaller branches be less than the branch from which they arise, their united caliber will be greater than that of the original branch; so that the vascular system really increases as it becomes more remote from the heart: it is in this way that anatomists, by reflecting on the divisions of this system, have compared it to a cone, the apex

of which is formed by the heart, and the base, by the extremities of the smaller vessels.

The symmetry of the vascular system is by no means so uniform as that of the nervous system. The heart and great trunks are not placed exactly on the median line, and the vessels that correspond are not all given off in the same manner; thus, the arteria innominata gives origin on the right side, to the subclavian and primitive carotid, which, on the left side, arise separately from the aorta; in general, however, the origin of the trunks is pretty uniform; while that of the branches is so variable that hardly any two subjects present the same arrangement.

Differences of vascularity in the different organs.—The organs do not all possess the same degree of vascularity; those which are the most plentifully supplied with blood-vessels are: first, the lungs, the tegumentary system, the pia mater and choroid membrane, the glands, the follicles, the cortical substance of the brain, the nervous ganglia, the muscles and glandiform bodies; secondly, those which are most abundantly supplied with lymphatic vessels are: the lymphatic ganglia, the serous membranes, the cellular tissue and glandiform bodies.—No vessels have hitherto been demonstrated in the cartilages and appendages of the skin. The azygos organs, which are divided into two lateral halves by the mesian line, receive the same number of vessels from either side; but there are but few organs, with the exception of the eye, the testicles and kidneys, that receive many vessels of each kind. Examined in those parts in which they are distributed and pass out, the vessels present a great number of divisions which form frequent anastomoses with each other.

The most minute vessels, known by the name of *capillaries*, are spread throughout every part of the body, as may be demonstrated by microscopic inspection and injections. The smaller, less delicate branches, are found more particularly on the superficies of the body; while the

branches are situated more deeply, and are embedded in a quantity of cellular tissue, which fills up the great interstices of the organs, particularly in those regions where flexion is performed. The vascular trunks are found exclusively in the cavities of the thorax and abdomen.

Mode of Division.—The mode of division of the vessels varies in the different parts of the body. Sometimes it consists in a bifurcation, and forms branches that correspond with each other in length and diameter; it is in this way that the aorta terminates in the abdomen; most frequently, however, a branch is separated from a trunk, which continues its course; in this case we observe no uniform proportion between the volume of the first and that of the second. The origin of the vessels is commonly near their place of destination, and it is seldom that we see them run any considerable distance without furnishing divisions: the spermatic artery is of the small number of those which form exceptions to this rule.

When they divide, the vessels form various angles, but, most generally, they are acute, especially in the extremities. The divisions of the great trunks, however, present many examples of right angles, while the superior intercostals, and recurrent arteries of the extremities are given off at a very obtuse angle.

Mode of communication.—The different kinds of vessels communicate with each other, not only because they result from the ramifications of the same trunks, but also from the connexions called anastomoses, which we shall describe in a subsequent part of this work.

Two vessels sometimes meet and unite to form an arch, from the convexity of which small branches are given off, especially in the neighbourhood of the joints, the intestinal canal, the hand, the foot, &c.; at other times, the communication is effected by means of an intermediate branch, as in the two anterior cerebral arteries, the vena cava and umbilical vein, &c. Two equal trunks sometimes unite at an

acute angle, and form but one, which takes a middle direction between that of the original trunks. It is thus that the two vertebral arteries unite and form the basilar. All the different kinds of anastomoses come under the head of one of the varieties which we have just noticed. They are more frequent in proportion as the vessels are smaller, more numerous and superficial. The anastomoses of the lymphatics are more numerous than those of the veins, and those of the veins than the arteries. Their principal object is, to facilitate the circulation of the fluids, and to maintain it by means of collateral passages, when one of the principal vessels has been obliterated: it is in this manner that the circulation is performed, although some of the larger branches shall have shrunk and even become obliterated.

Surfaces.—The vessels adhere by their external surface to the surrounding cellular tissue, which is condensed around them so as to form a sheath. Their internal surface is smooth, even, and slippery, continually moistened by a serous exhalation, and marked by semicircular projections, which correspond to the angles that are formed by the branches in separating from their trunks.

Structure.—The parietes of the vessels are formed of several cylindrical membranes, whose structure and other characters differ in the different kinds of vessels; we shall describe them in treating of the history of each order of vessels in particular. Their coats are thicker in proportion as their caliber is smaller; they receive minute branches of blood vessels and lymphatics (vasa vasorum,) and their nerves, which are derived from the cerebro-spinal centre and the great sympathetic, form a kind of reticulum around their external surface.

Physical and vital properties. The physical and vital properties of the vessels, as well as their functions, differ much, in the different kinds of vessels, as we shall remark in the following sections.

Mode of development and differences according to age.—The mode of development of the vascular system has not hitherto been examined, either in man, or in the mammiferæ, and all the knowledge that we possess on this subject has been derived from examining the eggs of birds. The *vitelline membrane*, which appears to correspond to the earachus of mammiferous animals, exhibits at first, small, isolated fissures, which are filled with a thin, transparent fluid, and which, as they increase in number, assume the form of a small tree whose trunk appears in a short time after, and forms the omphalo-mesenteric vein, which at this period contains red blood. It passes from below upwards, on the anterior surface of the embryon, dilates and forms the heart; the arteries are formed soon after, and finally the veins. These circumstances would induce us to believe that the embryon of the mammiferous animals is developed in the following order: that the umbilical vein is formed first, and that the development of the arteries of the belly precedes that of their corresponding veins; in short, that the order of appearance of the vessels is in proportion to the increasing quantity of the fluids which traverse them. The organs are at first mere hollow canals, embedded in the surrounding substance, which is gradually condensed around them so as to form distinct parietes; so that they acquire their proper texture only by slow degrees. In old age, the coats of the vessels, especially those of the arteries, become very condensed and brittle. As to the number of vessels, it is during fœtal life that it is the most considerable; and it is at this period that we find different branches which are obliterated after birth; such are the umbilical vessels, the ductus venosus and ductus arteriosus.

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The anomalies of origin, situation and form, are frequent in the vascular system; we shall have occasion to point out some of them in speaking of the different kinds of vessels.

We observe in the tissues, which have their analogies in the animal economy, as well as in cicatrices, adhesions and pseudo-membranes, vessels which are at first developed separately, like those of the urachus, and which communicate afterwards with those of the contiguous parts.

The pathological anatomy of the vessels varies so much in the different kinds of vessels, that it can not claim our attention on the present occasion: we shall revert to it in the following sections.

SECTION 2.

Of the Arteries.

Definition.—The arteries are the vessels which carry the blood from the heart to every part of the body.

Division.—There are two arterial trees, the pulmonary and the general; the first carries black, the second red blood.

General arrangement.—The arterial system consists of two principal trunks which arise from each ventricle of the heart. The one, called the pulmonary artery, arises from the right ventricle, and, as it ascends, it divides into two branches, one on either side of the aorta, the right to be ramified on the right lobes, and the left on the left lobes of the lungs; the other, called the aorta, arises from the left ventricle, passes upwards towards the superior part of the thorax, furnishes large branches, which are distributed on the neck, head, and superior extremities; after which, it forms a great curve, descends along the anterior part of the left side of the bodies of the vertebræ, furnishes branches to the viscera of the abdomen, and divides, between the fourth and fifth lumbar vertebræ into two secondary branches, which are distributed, after having sent branches to the pelvic viscera, on the inferior extremities.

The arteries, after a certain number of divisions, (twen-

ty-one according to Haller and Bichat,) terminate in the capillary system, where they are continuous with the radicles of the veins.*

Situation.—The arteries are generally situated more deeply than the veins and lymphatic vessels.

Form and diameter.—The form of the arteries is more uniformly cylindrical than that of the other vessels, and their diameter, ordinarily less than that of the veins which accompany them, diminishes in proportion as they recede from the heart; a circumstance not always observable in the veins and lymphatic vessels.

Relative number.—The number of the arteries is also much smaller than that of the veins and lymphatic vessels; thus, each artery of a middle size is generally accompanied by two corresponding veins and ten lymphatics. These differences, however, only relate to the general system, and, consequently, do not exist between the pulmonary arteries and veins.

Course.—In their course, the great arterial trunks, generally, follow a straight direction; the arch of the aorta and the internal carotid in the interior of the osseous canal, by which it enters the cavity of the cranium, form, however, exceptions to this rule. The small arterial branches and ramifications are generally more tortuous than the veins.

Anastomoses.—The anastomoses of the arteries are less numerous than those of the veins and lymphatic vessels; and this is particularly true with regard to the arteries that have a large caliber; the ductus arteriosus, between the aorta and pulmonary artery, in the fœtus, being the only instance of this kind of communication in the body. Notwithstanding, the anastomoses of the arterial system are sufficiently numerous to maintain the circulation by means

* Some are still visible after they have changed from vasa efferentia into vasa afferentia.

of collateral passages, after the great trunks, such as the abdominal aorta, the iliac and carotid arteries, &c. have been obliterated by the application of ligatures.

Surface.—The external surface of the arteries is surrounded by a loose sheath which is formed by the condensation of the surrounding cellular tissue, and which is particularly firm and dense in those parts which are subservient to locomotion. In several parts of the visceral cavities, this sheath is wanting, and its place is supplied by folds of the serous membranes. It is in this manner that the pericardium is spread over the origin of the arterial and venous trunks. The internal surface of the arteries is smooth and slippery, and, as we have already said, continually moistened by a serous exudation. At the entrance of the ventricles, it presents several valves, the only ones of the arterial system, and which we shall presently describe.

The parietes are stronger in the small than in the large arteries, in proportion to the size of the caliber, hence aneurisms are much less frequent in the former.

Structure.—The parietes of the arteries are formed of three cylindrical coats.

External coat.—The external coat is formed by the condensation of the laminæ of the cellular tissue which surrounds the arteries and connects them to the neighbouring parts. It admits of considerable extension, is the most resisting of the three, and the only one that is not divided when an artery is tied.

Middle coat.—This coat, which is sometimes called the *fibrous* or *proper* coat of the arteries, is formed by a yellow, very elastic tissue, analogous to that which is found in the trachea and yellow ligaments of the vertebræ. (See hist. of the yellow fibrous tissue.) It consists of spiral fibres, which but imperfectly surround the arteries; they cross each other in various directions, and are arranged in layers that may be easily separated. These fibres are strong, very elastic and their firmness is sufficient to maintain the

caliber of the arteries when they are empty. The middle coat adheres more intimately to the external than to the internal; and at the ventricles of the heart, it gives origin to three semi-circular festoons which correspond to the semilunar valves that they support.

Internal coat.—The internal coat, called also the *common coat* of the arteries, because it extends into the cavities of the heart, is thicker in the arteries of the general system than in those of the pulmonary, and has no apparent fibres; it is thin and diaphanous, eminently brittle, smooth and even on its internal surface, which is lubricated, and, adhering by its external surface to the middle coat. At the entrance of each ventricle, it forms three folds, which adhere to the circumference of the festoons that are formed by the middle coats of the arteries, and their floating margins, the centre of each of which is guarded by a corpus sesamoideum,* present in the direction of the course of the blood, and meet as tense chords, describing three radii of the circular aperture of the vessel. These folds are called the *sigmoid* or *semilunar* valves, and are of use in preventing the return of the blood from the arteries into the ventricles.

We see, from the preceding observations, that the cavities of the heart are lined by a continuation of the internal membrane of the arteries, and also, that this membrane is there confounded with the venous trunks in such a manner that the heart, composed in man of two lateral halves, may be regarded as a double portion of the vascular system, which differs from the others only in that its exterior envelopes, instead of being fibrous and cellular, are a network of muscular fibres.

The arteries are supplied with nerves, blood-vessels and

* This body serves to fill up the space which is left between the free margins of the valves, where they unite to close up the caliber of the vessels. (See the Works on Descrip. Anat.)

lymphatics. The nerves are larger and more numerous in the arteries of the pulmonary than in those of the general system, and proportionably in the small than in the larger branches. They are derived from the great sympathetic and spinal nerves.

Characters and physical properties.—The arteries are less dense and resisting than the veins, but they are thicker and enjoy a greater degree of elasticity, which is owing to their fibrous tunic. This property of the arteries is more appreciable in the direction of their length than in that of their circumference, and in the large than in the small arteries.

Vital properties.—The sensibility of the arteries is very obscure; and their power of vital contractility has been denied by a number of physiologists, especially by Haller, Bichat, Nysten, and lately by Magendie, who pretends that these vessels manifest no more signs of irritability under the influence of mechanical and chemical agents than under that of galvanism. But the facts, recorded by Zimmermann, Verschuir, Sœmmering, Hunter, Hastings, Parry, Ginglio, Rossi and others, prove incontestibly the incorrectness of the opinions of those who have denied the vital contractility of the arteries; and at the present day, most physiologists are of opinion, first, that the arteries contract; secondly, that this action is more remarkable in proportion as their caliber is smaller and their elasticity less.

The contractility of the arteries is rendered evident by their beats or pulsations, which constitute what is called the *pulse;* a phenomenon resulting not only from the motion or slight displacement of these vessels, caused by the shock which the blood receives from the sudden impulse of the ventricles, but also from the dilatation and contraction of their parietes in consequence of the intermittent afflux of this fluid.* Each of these two kinds of movements has

* By attentively observing each pulsatory motion, it can be demon-

been considered, in its turn, as the exclusive cause of the pulsations of the arteries, but it has been demonstrated that they are the result of the combined actions of both, and that the first prėdominates in the great trunks, and the second in the branches and ramifications. The pulsations of the arteries correspond, in general, with the contractions of the heart; and it is from these circumstances, that the pulse has furnished us with one of the most important sources of diagnosis in the examination of diseases. Its fulness, its development, its frequency, its quickness, its regularity, its equality, as well as its opposite qualities, afford us the means of judging of the danger and degree of intensity of the different diseases with which man is liable to be afflicted. In some inflammations, especially in those of a phlegmonous character, the pulsations of the arteries of the part affected, are generally somewhat accelerated, independently of the actions of the ventricles. We observe also, that in paralytic patients, the pulse is more feeble in the limbs that are deprived of motion than in the other parts; another proof of the contractility of the arteries.

Functions.—The arteries receive the blood from the heart and carry it to every part of the body. The motion of the blood is by no means uniform; each cantraction of the ventricles gives a propelling motion to its mass, which may be readily observed when an artery is divided; the blood then, it is true, will be seen to flow without interruption, but by jets and jerking motions, which are synchronous, like the pulse, with the contractions to which we have just alluded.

When the collateral branches of a large artery receive a larger quantity of blood than is natural, their calibers become considerably enlarged, not only by the dilatation of their parietes, but by an actual increase; for it must be re-

strated that there is a simultaneous elongation and dilatation, followed by a shortening and contraction of the arteries.

membered, that the parietes of an artery do not necessarily diminish on account of their development. On the contrary, the artery which has ceased to be traversed by the blood, shrinks, and is finally obliterated and converted into a kind of ligamentous cord: we shall not say that this is the result of its contractility, but a consequence of the cessation of its functions, the chief effect of which is, a diminution in the activity of nutrition.

Differences according to age.—The arteries are proportionably more elastic and more fully developed in infancy and youth than at any other period of life. In the decline of life, they lose their elasticity and become more and more brittle, and their ossification, which takes place at this period, may be regarded as a normal state, intended by *nature* to give strength to their middle coat, which is its ordinary seat. In old age, the parietes of the great trunks are thin and brittle, especially those of the general system.

Anomalies of origin.—Bichat, and since his time, Meckel and Béclard have observed that the anomalies of origin of the arteries are, in proportion to their number and volume, at least as frequent as those of the veins.* Meckel has seen ten anomalous origins from the arch of the aorta, while he has known but one from the vena cava superior. This author has made a similar remark with regard to the arteries and veins of the extremities.

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The arteries are subject to changes of form without lesion of their tissue. Thus, their volume may enlarge, either throughout their whole length, as parts that have been a long time inflamed, present examples,† or only in a part of

* Haller, Sœmmering, and the Walthers, have asserted the contrary.

† In this case, the thickness of the parietes corresponds to the dilatation as in the development of the collateral branches.

their extent. When the dilatation is local, (the true aneurism of the ancients,) it occupies either the entire circumference of the vessel, or, as is most frequently the case, only a part of it. The arteries are also subject to morbid contractions, which may be either general or partial; the first may be observed to take place, particularly in those parts where the vital action is languid and feeble; the second, more common in the great trunks, are sometimes the result of a local alteration of the tissue of the artery. Inflammation of the arteries is characterized by redness, and sometimes a thickening of their internal coat, and an effusion of coagulating lymph, which produces an adhesion of their parietes when they are brought in contact by compression, ulceration, gangrene, &c. The internal coat is the most subject to inflammation; the external resembles it in this respect, and when inflamed, it is rendered exceedingly brittle. Fungous growths are not unfrequent on the surface of the internal coat, especially in the neighbourhood of the valves. There are sometimes small encysted tubercles between this and the middle coat of the arteries, which terminate either by suppuration or ossification, so as to obstruct the caliber of the vessel. Ossification, so frequent, as we have just remarked in old people,* may also be observed sometimes to occur in adults; it is often confounded with earthy concretions, which are formed between the middle and internal coats, and enter the caliber of the artery by penetrating its internal membrane.

In consequence of the local dilatation of a part of the circumference of an artery, but more frequently without any previous dilatation, the internal coats being weakened from the constant impulse of the blood, or altered in their texture, give way and break. The cellular coat then becomes distended, and forms a tumour on the sides of the artery, with

* It is to this circumstance that must be attributed the ordinary cause of the spontaneous gangrene known under the name of *gangrena senilis*.

which it communicates by a ragged, and irregular opening. This constitutes what is termed the *true aneurism*—one of the most dangerous diseases of the arteries, and even of the animal economy. The aneurismal cavity contains coagula of blood, and its parietes are frequently lined with fibrous layers and pseudo-membranes. The tumour sometimes remains stationary, after having attained to a certain size; but more frequently it goes on gradually increasing, and demands the interference of the surgeon. It is seldom, indeed, that we see it diminish in consequence of spontaneous obliteration, and to induce this effect it is almost always necessary to obtain surgical aid. This disease presents so many varieties, that we shall necessarily be obliged to pass some of them unnoticed on the present occasion. The great trunks, and the large branches, especially those of the inferior extremities, are the most ordinary seat of this affection. *False aneurism* is a tumour formed by the effusion of blood into the adjoining cellular tissue, either immediately after a wound, or in consequence of the rupture of a cicatrix, (primitive false an.—consecutive false aneurism.)—Ligatures applied around healthy arteries, divide the internal and middle coats, while the external resists the cause of rupture, by dilating, and forms a tumour:—the blood is next arrested in its progress, and forms a coagulum between the ligature and the nearest collateral branch; inflammation supervenes, and at the end of forty-eight hours it determines the adhesion of the coats of the artery by means of an effusion of coagulating lymph, then the division of the tissues that embraced the ligature, its separation and removal, and finally the absorption of the clot, followed by the obliteration of the part of the artery which it filled. In cases where the external coats are broken, and the internal coat alone remains entire, cicatrization is also produced by the effusion of coagulating lymph, which increases the thickness of the parietes of the artery, and gives additional strength to its internal membrane; at

other times, the internal coat is distended, forms a tumour across the solution of continuity of the others, and constitutes what is called the *internal mixed aneurism.*

From the beautiful experiments performed upon dogs, by Jones and Béclard, with a view to determine the relative degree of danger resulting from wounds of the different coats of the arteries, it appears, first, that a very small puncture of an artery is followed by a slight degree of hemorrhage, by the formation of a coagulum which closes up the mouth of the wound, and by a complete cicatrization; secondly, that all other wounds of the arteries are fatal, if the cellular coat has been destroyed, excepting in the following cases: 1st, a longitudinal wound heals like a simple puncture, but there remains a linear cicatrix; 2d, a transverse wound embracing only one fourth of the circumference of the vessel, is susceptible of healing; 3d, when it occupies one half, it is followed by too great a separation of the edges of the wound, to permit of the formation of a cicatrix; it must then necessarily prove fatal; 4th, when it occupies three fourths of the vessel, it may heal, if the retraction of its extremities is sufficiently strong to accomplish a solution of continuity; 5th, when this is complete, the extremities retract within their cellular sheath, and after a profuse hemorrhage, syncope ensues, a coagulum is formed, and cicatrization takes place. In the human subject, the treatment of wounds of the arteries has hitherto been attended with little success; both on account of the difficulty of checking the hemorrhage, and of the want of firmness in their cicatrices. Gun-shot wounds, and those resulting from severe burns, however, seldom bleed profusely, the blood being retained by the eschars, which are not detached until after the obliteration of the artery. We shall say but little of lacerated wounds, in which the rupture of the coats of the arteries having taken place in succession from the internal to the external, gives a conical form to the extremity of the vessel, which, added to the

retraction by which the division of the artery is followed, presents a sufficient obstacle to the hemorrhage to allow of the formation of a coagulum.

SECTION 3.

Of the Capillary Vessels.

Definition.—The capillary vessels are formed by the termination of the arteries and the commencement of the veins.

The smaller ramifications of the vessels take the name of capillaries the moment that their tenuity becomes such as to be invisible to the naked eye. The most delicate that can be distinguished with the aid of the microscope present the diameter of a globule of blood, which, according to the experiments of Messrs. Prévost and Dumas, is equivalent to the 1-2800 part of an inch.

Division.—The capillary vessels may be divided into those of the pulmonary and those of the general system; the first being between the termination of the pulmonary arteries and veins, is distributed on the surface of the air-cells of the lungs, where the blood which circulates through it is changed from venous to arterial; while the second, which is between the terminations of the aortic arteries and the origin of the veins of the body, is disposed in different proportions to the compound solids of the body, and the blood which circulates through it is changed from arterial to venous. We shall speak more particularly of the physiological functions which belong to each of these two divisions, in a subsequent part of this section. Besides the two divisions just mentioned, there is a venous capillary system, which is formed by the terminations of the vena portæ and the commencement of the hepatic veins.

General conformation.—The capillary vessels form a large and beautiful net-work in the tissues of our organs;

and in proportion as they divide, they present a successive decrease in their small arterial ramifications, and a corresponding increase as they unite to form the commencement of the veins.

Situation.—The capillary vessels are spread throughout every part of the body, and form, by their union, the most extensive part of the vascular system. Many physiologists, during the last centuries, have supposed that our organs were formed exclusively of capillary vessels; but this opinion has not yet been proved, nor completely refuted, since we have no other means of proving the existence of the sevessels than injection—an art which has not hitherto been fully adequate to demonstrate them in every part of the body. Inflammation, it is true, may afford us some aid in elucidating this important question, since it is attended even in some of those tissues which can not be injected, such as the cartilaginous, &c. with a red and striated appearance, though it is doubtful whether these striæ are any thing else than simple hollow canals, formed accidentally in the substance of the organ that is inflamed. It remains then for us to examine the differences which exist between the different tissues in regard to the extent and number of the capillary vessels that can be demonstrated by injection. We may arrange them in the following order: first, *into those tissues that can not be injected,* which are;—the cellular tissue, the cartilages, the epidermis and its appendages. Secondly, *into those that can be but partially injected,* viz: the medullary substance of the brain and nerves, the fibrous system, except the periosteum and dura mater, the serous membranes and bones; thirdly, *into those that can be readily injected*; these are the adipose vesicles, the cineritious substance and neurilema of the nerves, the nervous ganglia, the muscles, but particularly the teguments, the glands and glandiform bodies. The lungs are, of all the organs, those which are the most abundantly supplied with capillary vessels.

Mode of communication.—The beautiful and well-conducted experiments of Leuwenhoeck, performed upon the mesenteries of frogs, the tails of fishes and other transparent organs, have fully and satisfactorily demonstrated the continuity of the arterial and venous capillaries: it has also been proved by injections, which may be readily thrown from the one into the other. The parenchymatous or spongy tissue, supposed by the ancients and some of the modern physiologists to intervene between the extremities of the arteries and the origin of the veins, has never been demonstrated, and all that has been said concerning it appears to be without foundation. We find in the reciprocal relations of the arterial and venous capillaries, the three kinds of communication, which we pointed out in speaking of anastomoses in general. If we examine an injected serous surface, whose capillaries have been carefully and minutely filled, we shall see that this system presents a complete network with fine meshes, in which no vessels run a distance of more than two lines without anastomosing with others.—The lymphatic vessels anastomose freely with the veins; but it is as yet doubtful whether they form any anastomoses with the arteries.

Structure.—The parietes of the capillary vessels can scarcely be distinguished from the substance of the surrounding organs, and all our knowledge of their texture consists in the mere supposition that they are formed by a continuation of the internal membrane of the arteries and the veins. They are interwoven with nervous filaments which are derived from the cerebro-spinal system and the great sympathetic nerve; and, it is from an assemblage of these, that the papillæ of the skin and mucous membranes are formed.

Hypotheses of different authors with respect to the existence of serous vessels, &c.—Boerhaave, and those who embraced the idea that our organs were entirely composed of vessels, have thought, as well as many anatomists, such

as Haller, Sœmmering, Bichat and Chaussier, that there was a set of vessels that were more delicate than the visible capillary terminations with which they were continuous, and which admitted only the serum of the blood. Boerhaave even went so far as to classify them into several orders. The facts upon which this opinion rests have been drawn from the following observations: first, from the circumstance that we can not form any idea of the manner in which nutrition takes place in those organs that can not be penetrated by injections; and secondly, from the fact that those parts which are naturally white, become red the moment they are in a state of inflammation. Bleuland is said once to have seen a set of pellucid vessels that arose from the terminations of the arterial capillaries.—To the observations advanced by the above physiologist, it will be sufficient to remark; first, that with the aid of a powerful microscope, the terminations of the vessels can be rendered sufficiently apparent, inasmuch, that if there were even a set of vessels more minute than the capillaries, they would necessarily be rendered evident; secondly, that we can perceive the vascularity of an organ by coloured injections, since the capillaries which admit only a single globule of blood at the time, appear perfectly transparent; whence it is natural to conclude, that if a trasparent organ becomes red when inflamed, it is owing, in part, to the irritation which increases the capacity of the capillary vessels, so as to admit, consequently, a greater number of globules at the time; thirdly, that the inflammatory blush is often the result of the injection of the whole substance of an organ. In summing up the facts of the preceding observations, it will be seen, that the serous vessels have been observed but a single time, and that they ought not, from the experiments of Bleuland, to be considered, in the present state of our knowledge, as a separate system.

Many anatomists admit the existence of extremely fine vessels, endowed with the power of transmitting from the

arteries, the materials of nutrition, and of exhalation, and of other capillaries equally delicate, whose office it is to take up and carry into the veins the exhalations and organic particles which are destined to re-enter the circulation. The first of these are called the *exhalent* and *nutrient* vessels, and the second the *absorbents;* but the existence of these intermediate agents has never been demonstrated by experiment, nor the open mouths of the capillary vessels, admitted by some anatomists, who have attributed to them the functions to which we have just alluded. None of these hypotheses are, however, necessary to the theory of absorption, and of exhalation; these being performed to a greater or less extent in all the tissues of the animal economy, and are a natural consequence of their *hygrométricité.*

Physical and vital properties.—The capillary vessels are exceedingly permeable; their sensibility varies in the different organs in which they are found, and their contractility is greater and more conspicuous than in the other parts of the vascular system.

Functions.—The circulation of the blood in the capillary vessels is performed by the immediate action of the heart, and by their own contractile power. Having already pointed out the differences that exist between the pulmonary and the general capillary systems, with regard to the change of colour which the blood suffers in traversing them, it may not be amiss to speak a little more in detail. In its passage through the capillaries of the lungs the blood is brought into contact with the atmospheric air, absorbs its oxigen, and exhales a small quantity of serosity, which is discharged during the act of expiration. Moreover, the capillaries which arise from the ramifications of the aorta, carry red blood, deposit into all the organs the materials of nutrition, losing in some of them those parts, which, being separated by simple exhalation, or by glandular secretion, either re-enter the vascular systems (recrementitial fluids,) or are thrown off from the economy (excrementitial

fluids;) then becoming venous capillaries, for the circulation of black blood, they absorb the recrementitial products which result from the functions just mentioned, and the remains of nutrition.

Erectile tissue. This tissue, which Béclard and several modern anatomists, have described separately, under the name of the *erectile tissue*, is nothing but a variety of the vascular reticular tissue, and is formed by a net-work of veins which are continuous with the arteries, and which, by their frequent anastomoses, form cells which communicate with each other. This tissue is well developed in some of the organs, especially in the corpus cavernosum penis, the clitoris, the nymphæ, the nipple, the papillæ of the tegumentary membranes, the spleen, &c.; it is plentifully supplied with nerves, and is supported by an elastic fibrous envelope. When its sensibility is exalted, it becomes the seat of a sanguineous fluxion, which lasts as long as the excitement that induced it continues to exist, and constitutes what is termed temporary erection: this phenomenon is produced in the sexual organs by the venereal desire, by degustation in the papillæ of the tongue; and by the cold stage of intermittent fevers, and a variety of other causes in the spleen.

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The caliber of the capillary vessels greatly enlarges whenever they are called to perform, by their anastomoses, the functions of an obliterated vessel. They are found every where in the accidental tissues, as in the pseudo-membranes and cicatrices, &c. In some parts, especially under the skin, they are developed so as to form masses, varying in size, configuration, and colour, resembling the vascular meshes of the erectile tissue, and, like them, are susceptible of temporary fluxion. This affection, termed *telangiectasia*, or *aneurism* by *anastomoses*, is generally of a congenital nature; and is vulgarly attributed to the

longing of the mother during pregnancy. To these preternatural dilatations may be referred those which constitute what are called hemorrhoidal tumours.

As soon as the capillary vessels are irritated, there is an afflux of blood which distends their caliber, and imparts a red colour to the affected tissues, whose volume becomes sensibly augmented. Sometimes these vessels are ruptured, and produce considerable hemorrhage, as the blood is effused into the surrounding substance, and forms what is termed a spontaneous ecchymosis; at other times, the redness and swelling become more considerable; the temperature of the part is elevated, and is accompanied with considerable pain and throbbing: this assemblage of phenomena constitutes inflammation—a morbid state which varies in its effects and termination. Inflammation of the capillaries sometimes terminates: first, either in resolution, or by an effusion of *lymph*, which remains either fluid, or coagulates so as to form false membranes, or it combines with the surrounding cellular tissue, and gives rise to tho white induration, and to all the changes of tissue which this kind of induration is capable of producing; secondly, by an effusion of *pure blood* which, by its intimate union with the parietes of the capillary vessels, and the neighbouring tissues, produces the alteration of structure called the *red induration* (induration rouge;) this morbid alteration is often found in the lungs, organs which are essentially vascular, and where, from its resemblance to the substance of the liver, it is called *hepatization;* thirdly, by the secretion of *pus*, possessing all the properties and distinctive characters which we pointed out in speaking of the cellular tissue. Inflammation also terminates sometimes in gangrene of the capillary vessels, and of the organs in which they are found. Fungous tumours and most of the diseases said to be organic are owing to long and constant irritation of these vessels.

SECTION 4.

Of the Veins.

Definition.—The veins are the vessels which return the blood from the capillaries of the different parts of the body to the auricles of the heart.

Division.—Besides the two trees, that correspond to those which compose the arterial system, the veins have a third, called the *vena portæ* which is formed by the union of the veins of the spleen, and of the whole digestive apparatus, and is ramified in the substance of the liver like an artery. The general venous system may also be divided into the superficial and deep seated.

General Conformation.—The veins, like the arteries, represent the figure of a tree whose trunk is the heart.

Comparative situation.—The situation of the veins is generally more superficial than that of the arteries;—striking examples of this remark are afforded by the subcutaneous veins, and even by some of the deep-seated, as in those of the brain. *Course.*—The course of the veins is not so tortuous as that of the arteries—a circumstance which materially contributes to facilitate the course of the blood, which traverses most of these vessels against its own gravity. *Number.*—The arteries are almost universally accompanied by two veins, seldom by one, which traverse with them the same osseous openings, and the same interstices of the soft parts.* We have already seen that the number of the veins is much greater than that of the arteries; this observation, though true in a general point of view, is not, however, applicable to the sanguineous vessels of each organ considered separately; for the intestinal ca-

* In the lungs, the intestines, &c. the small veins are folded upon the arterial ramuscles with which they are continuous, and follow for a considerable distance their mode of "arborisation."

nal, the kidneys, the testicles, &c., have each an equal number of arteries and veins, while the penis, the clitoris, the gall-bladder, and the umbilical cord, have each two arteries and only one vein; in these cases, however, the size of the veins is much greater than that of the arteries and compensates for the inferiority of number. *Origin and volume.*—The veins, arising in every part of the body, by innumerable microscopic radicles, which are continuous with the arteries,* unite in succession and form ramifications, then branches, and finally large trunks. When two veins meet, they unite and form one that is smaller, compared with each of the original branches, than a bifurcated artery, considered in relation to one of its divisions. Sometimes, there are even veins whose caliber is not greater than the branches from which they are derived;—a kind of anomaly more common in the most dependent parts of the body, because there the blood, circulating slowly and against its own gravity, exerts a greater degree of force on the parietes of the veins, naturally very extensible, in proportion as the column which is separated from the heart, is more considerable. *Capacity.*—The capacity of the venous tree is greater than that of the arterial, but not in the same proportion in every period of life; for in infancy, their capacity is nearly equal, while as we advance in life, it becomes more and more remarkable, and extremely great in old age. This difference probably exists only in the general system of the sanguineous vessels, and not in the pulmonary.

Anastomoses.—The anastomoses of the veins are extremely numerous, and may be observed to take place even between the large trunks; thus the two venæ cavæ communicate with one another by means of the azygos. They

* The transudation on the internal surface of the intestines, of the matter of injection in the veins, has led to the opinion entertained by some physiologists, that there are venous radicles that originate in open mouths. The reality of this anatomical fact, however, has by no means been proved.

are more frequent in those parts where the circulation of the blood is the least favoured, and where it may be interrupted by external agents, as in the subcutaneous veins, which communicate so often as to form a kind of net-work with large meshes.* There are also anastomotic communications between the superficial and deep seated veins, which, according to Bichat, "are more necessary in man, than in any other animal, on account of the pressure of his clothes," &c.

Form.—The veins are less uniformly cylindrical than the arteries, a circumstance which must be attributed in a great measure to the facility with which they can be distended. On the external surface of some of them there is a kind of aponenrotie rings, which correspond to the internal folds or *valves,* which we shall presently describe.

Structure.—The parietes of the veins are thinner than those of the arteries, and like theirs are composed of three coats, which are contained in a sheath common to all the vessels. The sinuses of the brain, which, until the time of Bichat, were regarded as being entirely composed of duplicatures of the dura mater, were proved by this great anatomist to be lined by a continuation of the internal membrane of the veins.

External coat.—The external or cellular coat is less dense and resisting than that of the arteries, and when isolated, does not, like theirs, retain its cylindrical form; it is intimately united to the middle coat, in the thickness of which it sends prolongations which extend as far as the internal membrane.

Middle coat.—The middle coat of the veins is so thin and indistinct, that its existence has been denied by some very able and skilful anatomists; it is most conspicuous in the subcutaneous veins and in the great venous trunks, especially in the venæ cavæ; is of a loose texture and is com-

* The spermatic veins and those of the pelvis also present a retiform arrangement.

posed of longitudinal reddish fibres, which admit of a considerable degree of distention, are difficult to break, as was proved by the experiments of Wintringham, and can be distinguished only in the larger veins near the heart. The middle coat appears to be wanting in the veins within the bones; and in the sinuses of the brain, its place is supplied by duplicatures of the dura mater. Its chemical composition shows that it consists principally of fibrin.

Internal coat.—The internal or common coat is thin, smooth, and polished, of a filamentous texture, and much more extensible and resisting than that of the arteries; it is a mere continuation of the membrane which lines the cavities of the heart, and alone constitutes the veins within the bones and the sinuses of the dura mater. On its internal surface it presents a great number of parabolical folds that are called valves, whose convex edge is attached, and presents towards the origin of the veins, while the other, which is straight or slightly concave, is directed towards the heart. The valves are applied against the internal surface of the vein by the motion of the blood that is contained in its canal: whenever there is a retrograde motion of this fluid, it escapes between the membranous folds, and the parietes of the veins, so that the valves become almost perpendicular to the vessel, and form a species of bag, whose cavity, being directed towards the heart, receives the blood, and prevents its return. They are generally large enough to close the canal of the vessel; but sometimes they are imperfect, and are mere projections, or transverse bands, as we see examples in the femoral vein and in the sinuses of the dura mater. Sometimes, the veins also present anomalies, such as fissures, on their free edges, a reticular structure, &c.—anomalies which are either congenital, or, as is most frequently the case, a consequence of the mechanical action of the blood. They are generally found in pairs, and are placed oppositely to one another; in the smaller veins, however, they are single;

and sometimes, instead of two, there are three or four. The existence of the valves is generally uniform, but in some veins, as in the minute ramifications, and the great visceral trunks, they are entirely wanting; they exist chiefly in the superficial veins, especially in those of the extremities, and are more numerous and nearer each other in the small than in the large veins. They are generally found at the junction of the ramifications with the branches, and of these with the trunks. The valves prevent the retrograde flow of the blood, facilitate its progress towards the heart, and are chiefly situated in those parts where its circulation is most difficult.

The veins receive but a small proportion of vasa vasorum, and of nerves, and these are principally derived from the ganglia. The nerves which supply the pulmonary veins are chiefly from the anterior pulmonary plexus.

Characters and physical properties.—The veins are of a whitish, semi-transparent colour, very extensible, and susceptible of a considerable degree of dilatation; they are less elastic than the arteries, and their parietes have not sufficient firmness to retain their caliber, when empty, unless they adhere by their external surface to the surrounding parts.

Vital properties.—The veins enjoy but an inconsiderable degree of sensibility, and their contractility of texture can be distinguished only in the larger trunks.

Differences according to age.—We have already seen, that the capacity of the venous system is about equal to the arterial in infancy, but it is greater in the adult, and still more so in old age. This difference shows, that in proportion as we advance from the cradle to the grave, the circulation becomes more languid, and that the decay of our organs exceeds their growth; two causes, which by accumulating a greater quantity of blood in the veins, determine their dilatation with a diminution of their parietes. Ossification and depositions of earthy phosphates, so com-

mon in the coats of the arteries, seldom take place in those of the veins.

Functions.—The veins bring back the blood to the auricles of the heart, after it has furnished the materials of secretion and nutrition, and receive the fluids which have been absorbed by the lacteals and absorbents. The circulation of the veins is rendered evident: first, by the phenomena which attend the application of ligatures, viz. by the obliteration of their caliber between the heart and the ligature, and their distention between this last and the venous capillaries; secondly, by the direction of the valves; thirdly, by microscopic observations. The motion of the blood in the veins is uniform and uninterrupted. The veins present no pulsations, except in those cases, where in consequence of impeded respiration, or an organic affection of the heart, the contraction of the right auricle causes a reflux of a portion of the blood into the venæ cavæ, while the other passes into the right ventricle.* The motion exerted upon the parietes of the veins by the blood thus repelled, constitutes the *venous pulse*, which can be distinguished only in the great branches, near the heart. The circulation of the blood in the veins is produced; first, by the contraction of the left ventricle, which has a considerable influence on the course of the blood in the veins; secondly, by the specific action of the parietes of the veins; thirdly, by the contraction of the surrounding muscles; fourthly, by the suction of the blood of the venæ cavæ, which is produced by the dilatation of the right auricle of the heart, and is more remarkable, when, from the tendency to a vacuum, the lungs are called into greater action.† Finally,

* This reflux also takes place in health, especially during expiration, but it is not sufficient to be appreciated on the exterior of the body.

† Dr. Barry, in a work which he has published on the causes of the circulation of the veins, states a number of recent experiments, by which he tends to prove, that the blood traverses the veins only during inspiration: but it appears to us that he has exaggerated the influence

the direction of the valves and the great number of anastomoses favour the circulation of the blood in the veins.—All these causes, however, are by no means capable of producing a force equal to that which the arterial blood receives from the action of the heart, and are not sufficient completely to neutralize the laws of gravitation.*

M. Magendie and some modern physiologists have performed a great number of experiments on the veins, and have clearly and satisfactorily demonstrated that they are absorbents. This opinion, entertained by Galen and his successors until the time of T. Bartholine, combined with that which denies to the lymphatic vessels any other office than that of mere absorbents of the chyle, will be more fully discussed in the history of the lymphatic system.

Pathological Anatomy.

The veins are frequently subject to dilatations, which occupy either the whole or only a part of their circumference, and constitute what are termed *varices*. These affections are generally produced by the pressure of the blood against the parietes of the veins, and are consequently more common in those parts where the blood circulates against its own gravity, and where it is impeded in its course, as in the veins of the inferior extremities, the pelvis, &c., varicose veins often present a serpentine direction, which indicates an increase not only of their caliber, but also of their length.—Instances have been related where the whole venous system was in a varicose state.†

which inspiration has on the motion of the blood, in regarding it as its essential cause, and as the cause of the dilatation of the auricles.

* According to M. de Blainville, the dilatory progress of the blood in the veins, allows the elements of this fluid a longer time to favour the modifications which they undergo by their mutual reaction; modifications, which are not, as has been hitherto supposed, the result of an organic action of the parietes of the vessels.

† Puchelt, author of a German work on the diseases of the veins,

The *aneurismal varix* is a tumour, arising from a preternatural and direct communication between a vein and an artery. It is generally caused by wounds or by the ulceration of the contiguous parietes of the two vessels. When a consecutive false aneurism is formed in the intermediate tissue between two injured vessels, it is termed *varicose aneurism.*

Morbid contractions of the veins are more uncommon than dilatations, but when they do occur, they depend most frequently, either on an obstruction of the circulation, or a chronic inflammation, which produces a thickening of their parietes, or an effusion of a plastic and membraniform matter, which lines their internal surface. In some instances the venæ cavæ and the jugular veins are thus completely obliterated, without causing an interruption of the circulation. This alteration may be either general or local. Wounds of the veins heal more readily than those of the arteries; and their cicatrization, though not immediate, is produced by an effusion of coagulating lymph, which closes up the lips of the wound. When a vein has been completely divided, the two extremities retract, like those of an artery, but the coagulum which closes up their caliber is smaller, and the part of the vessel which has ceased to perform its functions, is obliterated and converted into a cord. Wounds of the veins are more frequently followed by inflammation and ulceration than the arteries. Ligatures applied around them divide the internal coat only secondarily, and through the medium of the inflammation which they create.

Phlebitis or inflammation of the veins is a frequent disease, and generally arises from one of the following causes; 1st, from wounds of the veins; 2d, from the application of ligatures; 3d, from inflammation of the surrounding tis-

strongly insists upon this general dilatation, which, according to him, constitutes an important character in many diseases.

sues; 4th, from a varicose state of these vessels. The anatomical characters of inflammation, are, a considerable degree of redness of the internal membrane, accompanied by a thickening of the other coats; by collections of purulent matter on the external surface of the vein, and an effusion of coagulating lymph on its interior. Inflammation of the veins generally travels in the direction of the heart, and sometimes even extends as far as that organ, and destroys the life of the patient. The parietes of the veins seldom ossify, but sometimes there are small inorganic concretions, of the size of a millet seed, or a small pea, which occur more particularly in the veins of the pelvis, and in those where the course of the blood is most difficult. These productions, called *phlebolithes*, sometimes adhere to the internal surface of the veins, are commonly situated in the dilatations of these vessels, and are covered by a very thin membrane. They consist of several layers, and often appear to be fibrous.

SECTION V.

Of the Lymphatic System.

1. OF THE LYMPHATIC VESSELS.

Definition.—The lymphatics are small transparent vessels, which originate in every part of the body, and unite to form several trunks, which terminate in the general venous system.

The lymphatics which arise on the surface of the intestines are denominated the lacteal or chyliferous vessels, while those which originate in the substance of the organs are called the true lymphatic vessels.

General conformation.—The lymphatic system presents rather a reticular than arborescent arrangement, and consists of a multitude of vessels which communicate with

each other by numerous ramifications, and terminate in two principal trunks.

Situation.—All the organs, with the exception of the brain, the spinal marrow, the eye, the internal ear, and the placenta, contain lymphatic vessels. Like the veins, they are distributed in superficial and deep seated:—this arrangement exists not only in the extremities and in the parietes of the visceral cavities, but also in the organs that are contained within these last.

Volume.—The volume of the lymphatic vessels is smaller than that of the veins; but in this respect they present less difference between their ramifications and branches, and remain small, notwithstanding their successive union. The lymphatic vessels of the head are the smallest in the body; those of the superior extremities are a little larger; while those of the trunk and the inferior extremities are the most voluminous. *Number* and *capacity.*—The number of these vessels is much greater than that of the veins, there being on an average ten lymphatics to a venous or arterial trunk; which accounts for the fact that their united capacity is equal to that of the venous system, notwithstanding the exiguity of their volume. *Form.*—The form of the lymphatic vessels is that of small tubes intersected by numerous nodosities, which correspond to the valves on their internal surface.

Origin.—The origin of the lymphatic vessels has hitherto eluded all our researches; and all the knowledge we possess upon this point, is involved in the mazes of hypotheses. The continuity of their roots with the arterial capillaries is still doubtful, and has been proved only by the single fact that matter of injection has sometimes been found to penetrate from the arteries into the lymphatics. This phenomenon, attested only by a small number of experiments, does seldom take place unless there be a rupture of the small arteries. Be this as it may, it is certain that the lymphatic vessels arise in the interior of the organs, and, ac-

cording to some anatomists, on the surface of the tegumentary and serous membranes. The most delicate lymphatic roots that can be discovered, anastomose so frequently with each other, as to form complete meshes, sufficiently compact to constitute the basis of some of the organs, such as the serous and tegumentary membranes, &c. Their larger branches communicate together at more considerable distances, yet their anastomoses are always more numerous than those of the veins, and present every where a reticular arrangement. *Course.*—On the course of these vessels are found every where the absorbent or lymphatic glands, which are entered on the side remote from the thoracic duct by numerous ramifications of the absorbent vessels, termed vasa inferentia; which escape on the near side by a smaller number, termed vasa efferentia. Most of the lymphatic vessels pass in this manner through several glands, especially those of the mesentery, where these glands are more numerous than any where else; while those of the extremities run a considerable distance, and even several feet, without meeting them. *Termination.*—The lymphatic vessels terminate in two principal trunks; the one, termed the thoracic duct, commences at the *reservoir* of Pecquettii, opposite to the second lumbar vertebra, and terminates in the left subclavian vein, after having received the lymphatic vessels of the inferior extremities, the abdomen, a great part of the thorax, the superior left extremity, and of the left lateral half of the head and neck. The other, termed the *vena lymphatica dextra,* is formed by the union of the lymphatic vessels of the superior right extremity, by a part of the chest, and the right lateral half of the head and neck; and terminates, after a very short course, in the right subclavian vein.* A great number of

* An anatomist of Florence, Doctor Rigolo Lippi, has lately discovered several other lymphatic trunks of a large size, and three smaller ones, terminating in the vena cava inferior, near the third lumbar vertebra; a

the lymphatics terminate directly in the neighbouring veins. This fact, well known at the present day, accounts for the rapidity with which substances that have been absorbed, enter the circulation.

Surfaces.—The external surface of the lymphatics is uneven, and adherent to the surrounding parts; the interval is smooth and furnished with a great number of valves.

Structure.—The parietes of the lymphatic vessels are composed of two membranous layers, and of the cellular sheath common to all the vessels. The external membrane is strong and firm, and from its filamentous texture, has been supposed to consist of muscular fibres; the internal is extremely thin and brittle, and forms the numerous valves which are found on the interior of the lymphatic vessels. These folds are arranged, as in the veins, either in pairs, or single, and are generally of a parabolical form, but in some of the lymphatics, as in those of the liver, they are annular. They are very numerous in the branches, and still more so in the ramifications, while there are but few in the trunks.—There is a pair of these valves at the union of the lymphatic trunks with the subclavian veins, to prevent the regurgitation of their contents.—The parietes of the lymphatic vessels are supplied with arteries, veins, and lymphatics, but no nerves have as yet been discovered in them.

Physical properties.—In proportion to the thickness of their parietes, the lymphatic vessels have more resistance than the arteries and the veins.—They enjoy a great degree of extensibility, and are susceptible of retraction after death;—a fact which proves their elasticity. On these properties depend the astonishing variations of volume of the lymphatics, accordingly as they are full or empty.

Vital properties.—The vital contractility of the lym-

fourth terminates in the primitive iliac, and some others, which are distributed to the renal veins.

phatic vessels is sufficiently evident; but their sensibility is so obscure that it can be distinguished only when they are in a state of inflammation.

Differences according to age.—Our knowledge of the lymphatic system is too limited to enable us to say any thing decisive with regard to the varieties of form, capacity, &c., of these vessels, in the different periods of life. Pathological observations would induce us to believe that they are more fully developed, and enjoy a greater share of vital energy in infancy and youth than at any other periods of life.

Functions.—The office of the lymphatic vessels is to take up in every part of the body, and on the surfaces of all the membranes, the substances which enter the circulation;—to furnish the blood with the chyle and lymph, to convey them to the thoracic duct, and evacuate them in the venous system. As some of these functions, however, have been denied to the lymphatic vessels, we shall here enter into a brief detail of some of the facts that have been advanced in favour of their absorbent powers, as well as some of those of an opposite character.

The ancients, who were entirely ignorant of the existence of the lymphatic vessels, regarded the veins as the sole agents of absorption. This opinion prevailed until the time of Hunter and Cruikshank, who ascribed the power of absorption to the lymphatics, which, from that period, received the name of absorbent vessels, and retained it exclusively until 1809. At this period M. Magendie, the celebrated French physiologist, published several experiments which tended to prove: 1st, that an animal would survive several days after the thoracic duct was secured by means of a ligature; 2d, that it would neither accelerate nor retard the effects of poison; 3d, that poison exposed to a surface which communicated with the rest of the body only by an artery and a vein, would prove equally fatal to the animal economy; 4th, that colouring and

odorous substances could be detected in a very short time in the veins, but not in the lymphatic vessels. From these facts M. Magendie concluded, that the veins possess the faculty of absorption, that the chyliferous vessels absorb chyle only, and that the rest of the lymphatic system is devoid of this function. This manner of explaining absorption was adopted by the most celebrated German physiologists, who, with M. Ribes repeated and modified the experiments of Magendie. The researches of M. Ribes led him to suppose that a certain proportion of the veins commence in open mouths, or in the pores of the laminous tissues of the organs, and that he saw traces of pus and fat in the venous system, while he searched for them in vain in the lymphatic vessels. In the further investigation of this subject, M. Segalas submitted poisonous substances to the action of a portion of intestine, having previously insulated it, and carefully secured its vessels, with the exception of an artery and a corresponding vein, which were left uninterrupted to preserve the life of the part: the presence of the poison was not evinced in the system, nor did it prove fatal to the animal until after another vein was untied. All these experiments, and others of nearly a similar nature and with the same results, gave rise to the opinion, adopted by a great number of physiologists of the present day, that the *veins are the sole agents of absorption.* The discovery of Mr. Fohmann, an anatomist of Heidelberg, of a communication of the lymphatic vessels with the veins, and of a great number of lymphatics in the lymphatic glands, and in the substance of the organs, appears to be sufficient to account for the results of the preceding experiments. The important discovery of Dr. Lippi, and the researches of Mr. Lauth junior, concur to support the observations of Fohmann. Mr. Lauth asserts, that the veins are continuous with the arteries, and that they do not, as has been supposed by some, originate in open mouths, and also that they are des-

titute of inorganic pores; whence he concludes, that the lymphatics possess the faculty of absorption, and that there is no proof that the veins perform this function, since foreign substances, found in the blood, are carried directly to the circulation, their elimination being hastened by the numerous lymphatic branches which communicate with the veins in the interior of the lymphatic glands, and in other parts of the system.

Such is the present state of our knowledge with regard to the true agents of absorption. No doubt this faculty does not belong exclusively to the lymphatics and the veins, since it takes place to a greater or less extent in all the tissues of the body.

2. OF THE LYMPHATIC GANGLIA.

Definition.—The conglobate glands or lymphatic ganglia, are small oval bodies, situated on the course of the lymphatic vessels.

Form and volume.—These ganglia are more round and globular in proportion as their volume is smaller, and more flattened and elongated in proportion as it is more considerable. Their size varies from a lentil to that of an almond.

Situation.—The lymphatic ganglia are found chiefly in the neighbourhood of the great joints, especially in the armpits, the groins, &c. but they are still more numerous in the thoracic and abdominal cavities, and, in general, in the vicinity of the lymphatic trunks and the surface by which new substances are introduced into the animal economy.

Structure.—These glands appear to consist of a soft, fleshy, porous substance, contained in a membranous capsule, which is derived from the condensation of the cellular tissue in which they are embedded: they are essentially composed of the vasa inferentia, of blood vessels which anastomose with them, and of filaments of nerves.

Physical characters.—The lymphatic ganglia are firm and resisting, and vary in colour in the different regions in which they are found. They are of a yellowish tint in the neighbourhood of the liver, white in the mesentery, and of a dark brown colour around the bronchia and the spleen.

Vital properties.—The vital properties of these glands are too obscure to be appreciated in the healthy state.

Differences according to age.—The lymphatic ganglia are larger, more soft, and of a deeper colour, and enjoy a greater degree of vital energy in infancy than in the subsequent periods of life. In old age, they sometimes waste to such a degree, as almost entirely to disappear.

Functions.—The lymphatic and lacteal vessels all pass through these glands, by which the lymph and chyle are supposed to undergo certain changes, and to begin to be mixed with the blood. They are probably also of use in entangling noxious and acrid particles, and in preventing them from entering the circulation.

Pathological Anatomy.

Congenital anomalies are frequently met with in the lymphatic system; thus the thoracic duct is sometimes double, or it splits into two branches, one of which enters the subclavian vein, and the other the internal jugular. The lymphatics, like the veins, are subject to dilatations, which are produced by mechanical causes, and are termed *cirsus.* Sometimes we see a portion of a lymphatic vessel filled with a number of small vesicles which have been considered as hydatids by some authors, and have been referred to alternate enlargements and contractions between the intervals of some of the valves. The lymphatic system is often affected with inflammation, which is generally slow in its progress, and gives rise to various morbid phenomena which may be attributed to a scrofulous diathesis. It may terminate in suppuration, the effusion of albumin-

ous matter, or in the obliteration of the parietes of the vessel.

The lymphatic ganglia also, present many varieties both as regards their form and situation: they are subject to inflammation, to schirrous, carcinomatous and tubercular affections. Ossification, or the deposition of earthy matter, is more frequent in these glands than in the lymphatic vessels, and may be observed to occur sometimes even at a very early age. Inflammation of these glands terminates more frequently in induration than in any other tissue.

Bibliography of the Vascular System.

The treatises on general and pathological anatomy already cited.

1°. *Arteries.*

Haller. Oper. minor., tom. I, page 60—241.

Rolando. Mémoire sur la formation du Cœur et des Vaisseaux artériels veineux et capillaires: inséré dans le Journal complémentaire du Dictionnaire des Sciences médicales, tom. XII, page 34.

Corvisart. Essai sur les maladies du Cœur et des gros vaisseux. Paris, 1806.

Hodgson. Maladies des Artères et des Veines, trad. par *M. Breschet.* Paris, 1809.

Bertin. Traité des maladies du Cœur et des gros vaisseaux, rédigé par J. Bouillaud. Paris, 1824.

D. Belmas. Structure des Artères, leurs propriétés, leurs fonctions et leurs altérations organiques. in 4o. Strasbourg, 1822.

Fr. Tiedemann. Tabulæ Arteriarum corporis humani. Carlsruhæ, 1822.

Scarpa. Mémoire sur l'Anévrysme, traduit par M. Delpech. Paris, 1809.

A. Béclard. Sur les blessures des Artères, Mémoires de la Société médicale d'Emulation, tom. VIII, Paris, 1817.

Voy. sur la ligature de l'aorte les *Œuvres chirurgicales*

de *A. Cooper* et *B. Travers*, traduites de l'anglais, 2 vol. in 8o. Paris, 1823.

2°. *Capillaries.*

Malpighi. Epist. II, in oper. omn.

Leuwenhoeck. Exper. et contempl. arcan. natur. detect. epist. 65—67.

Spallanzani. Expériences sur la circulation, p. 255. Trad. de l'italien par J. Tourdes. In 8o. Paris, an 8.

Proschaska. De vasis sanguin. capill. *in* disquisit. anat. physiol. organismi corp. hum. Viennæ, 1812.

3°. *Veins.*

We possess no special information on the anatomy of the veins, considered in their healthy state, but what is found in the treatises of general anatomy. On the diseases of the veins consult the following memoirs:—

M. J. Bouillaud. Recherches cliniques pour servir à l'histoire de la Phlébite, etc., deuxieme article, Caractères anatomiques, dans la Revue médicale, juin 1825.

M. F. Ribes. Exposé succinct des Recherches sur la Phlébite, même recueil, juillet 1825, et Mémoires de la Société médicale d'Emulation, tom. VIII, 1816.

M. J. Bouillaud. De l'oblitération des veines et de son influence sur la formation des hydropisies partielles, dans les Arch. génér. de Med., juin 1823, pag. 188, et mai 1824, pag. 194.

4°. *Lymphatics.*

Cruikshank. Anatomie des Vaisseaux absorbans, trad. de l'anglais par Petit-Radel. Paris, 1787.

Lauth fils. Essai sur les vaisseaux lymphatiques. Strasbourg, 1824.

The persons who are desirous of having a knowledge of the recent works on the organs of absorption, will find the greater part in the following memoirs:—*Magendie,* Mémoire sur les organes de l'absorption chezles Mammifères (Journ. de Physiol. exper., tom. I, p. 18,)—Voy. aussi son Précis élém. de physiol., tom. II, pag. 179, 192 et 257.

2e. édit. Paris, 1825.—*Segalas*. Note sur l'absorption intestinale. (Recueil précité, tom. II, page 11.)—*Ribes*. Mém. de la Soc. méd. d'Emul., 1817, tom. VIII, p. 604 et suiv.—*Tiedemann* et *Gmelin*, Recherches sur la route que prennent diverses substances pour passer de l'estomac et du canal intestinal dans le sang, trad. de l'allemand. Paris, 1821.—*Fodera*, Recherches expérimentales sur l'absorption et l'exhalation. Paris, 1824.—*Vertrumb*, Mém. ins. dans le Journal complémentaire du Dictionnaire des Sciences médicales, tom. XVI, page 225, *Seiler* et *Ficinus*, Expériences sur le pouvoir absorbant des veines, même recueil, tome XVIII, p. 318, et tome XIX, p. 125.

Alard. De l'inflammation des vaisseaux absorbans lymphatiques, dermoïdes et sous-cutanés, 2e. édit. Paris, 1824.

S. Th. Sœmmering. De morbis vasorum absorb. corp. hum., in 8o. Traj. ad Mœn. 1795.

CHAPTER III.

OF THE SEROUS SYSTEM.

SECTION 1.

General Observations.

Synonyma: Simple villous membranes, diaphanous membranes, &c.

Definition.—The serous system consists of an assemblage of cystiform membranous organs, insulated from each other, and presenting two surfaces; one of which is free, every where contiguous to itself and continually moistened by the exhalation of a fluid, which resembles the serum of the blood; the other rough and adherent to the surrounding parts.

Division.—The serous system is divided into two parts, the splanchnic and the synovial; the first comprehends the tunica vaginalis testis and the serous membranes contained in the visceral cavities; the other the synovial membranes of the joints, the bursæ mucosæ, &c.

Conformation.—The different membranes of which the serous system is composed, represent shut sacs, which may be compared, according to Bichat, to "those night caps which are folded within themselves." The peritoneum, however, differs somewhat from this characteristic conformation of the serous membranes. The fallopian tubes penetrate into its cavity, and furnish by this arrangement the only example of continuity between the serous and mucous membranes.

Surfaces.—The serous membranes adhere by their external surface to the surrounding parts, very intimately in some places, and very loosely in others. Thus it is extremely difficult to separate them from the lungs, the spleen and the testicles, as well as from the articular surfaces, except where they begin to be folded on themselves. The first may also be very readily separated from the subjacent parts in the neighbourhood where they pass from one organ to another. The external surface is somewhat rough, rugose, and covered by a layer of cellular tissue, whose density varies in the different parts of the same membrane. This surface constitutes, by its reflections, numerous folds, of which the omentum and the mesentery are well marked examples.

The internal surface, every where contiguous to itself, is smooth and shining, continually moistened by a serous exhalation, and presenting numerous villi, which can be distinguished only with the aid of the microscope.

Texture.—The serous membranes are formed of a single layer, whose texture is more compact in proportion as it is examined near their free surface. Their tissue may be regarded as a modification of the cellular; indeed, when a portion of serous membrane is powerfully distended, we may perceive a great number of layers and filaments, which are irregularly interwoven with each other. Besides, when the serous membranes are inflamed they become red, a character which belongs also to the cellular tissue. This, as well as the first, is the seat of a serous exhalation, whose properties are nearly of the same nature. Add to this that accidental serous membranes (*cysts*) are sometimes formed in the cellular tissue by its simple condensation; that, exposed to putrefaction, both tissues resist for a long time its action, and that their maceration is equally slow and tedious. Most authors regard the serous membranes as being very abundantly supplied with pellucid vessels, which do not carry red blood in their healthy state; while Rudolphi

and Ribes, relying upon the results of the most minute dissections, assert that the serous membranes are destitute of every kind of vascularity.

Characters, physical and chemical properties.—The serous membranes are white and transparent, and enjoy some degree of elasticity, which is chiefly appreciable by the facility with which they recover their original state, after they have been considerably distended. Although very extensible, they are not so much so, as the enormous distention of which they are capable in certain dropsies, would induce us to believe. It ought not to be forgotten also, that the folds which these membranes present in their healthy state, are effaced by these diseases, and that they are susceptible of considerable displacement, when the cause of distention operates only on a portion of their extent. Maceration renders them opake; desication, on the contrary, increases their transparency. Subjected for a long time to the action of ebullition, they furnish gelatine and albumen.

Vital properties.—In their healthy state, the serous membranes are destitute of sensibility, and that which is observed when they are inflamed, probably belongs to the subjacent tissues. Their nutrition supposes that they are possessed of some degree of vitality, inappreciable in any other manner.

Differences according to age.—The serous system is extremely delicate in the fœtus: the arachnoid membrane and the omentum, which remain the most thin and delicate through life, have, in the fœtus, scarcely the thickness of the parietes of a soap-bubble. The density of these membranes increases with the age of the individual, and is in an inverse ratio with its elasticity. In old age, the adhesions of these organs become stronger and more resisting, while in infancy they are loose and feeble. The serous membranes accommodate themselves to all the changes of

form, and the normal displacements of the organs upon which they are spread.

Functions.—The serous membranes serve to line the visceral organs, and to insulate them from each other. This insulation is rendered more complete by the presence of the serum which lubricates their free surface, and which serves to facilitate the motions, and prevent adhesions of the contiguous parts. As to the separation of this fluid, Ruisch has demonstrated, that it is not derived from a glandular elaboration, as was supposed by many before his time. At the present day most physiologists are of opinion that it is a perspiratory secretion, an organic action of the serous tissue, or only of the vessels which are distributed in its texture: some very distinguished physiologists, however, suppose that this texture performs no other part of the exhalation of which we are treating, than that of a hygrometric substance.* The nature and quality of this perspiration vary in the different kinds of serous membranes; it re-enters the circulation in proportion as it is exhaled, and undergoes probably, during this double process, a modification which renders it more fit for nutrition. Bichat, in demonstrating that the extent of the serous surfaces, independently of the synovial membranes, was equal to the tegumentary membranes, showed the great importance of the serous exhalations and absorptions.

Pathological Anatomy.

The serous membranes are sometimes thickened at the same time that their extent is increased. This phenomenon, which is often observed in herniæ and dropsies, results from a hypernutrition (sarcroît.) The solutions of continuity of these organs are followed by a linear cicatrix,

* Rudolphi, who denies every kind of vascularity to this system, thinks that the serous exhalation is derived from the subjacent vessels, and that it traverses the serous membranes to arrive at their free surface, in the same manner as the cutaneous perspiration traverses the epidermis.

which is almost imperceptible when the reunion has been immediate, and by the formation of a new portion of serous membrane, when immediate reunion has not been effected: this portion remains always more thin, and more extensible than the rest of the membrane. The first effect of inflammation of the serous membranes is a suspension of the serous exhalation, which soon after increases, and becomes altered in various ways. Sometimes it is changed into a lactescent fluid, holding in suspension small, albuminous flocculi; at others, it is of a more consistent nature and of a gelatinous appearance, and is deposited on the free surface of the membrane in the form of small particles, which are converted into layers of greater or less extent. These pseudo-membranous productions become frequently organized, and establish permanent adhesions between the different parts of the organs of which we are now treating. In cases of this kind, they at first assume the firmness of cellular tissue, and finally that of serous membrane; vessels may also be observed to form in their centre, and to inosculate, by their ramifications, with those of the surrounding parts. Their mode of adhesion to the original membrane, as well as their disposition, their form and thickness, presents a great number of varieties. They are sometimes found under the form of bands, filaments, fringes, &c. They are most frequent in the pleura, and the peritoneum; and in the synovial membranes they sometimes result from the effects of rheumatism; they are liable to be converted into cartilaginous and osseous transformations. It should also be observed, that inflammation sometimes terminates in the secretion of purulent matter, which, according as it is more or less thick, and more or less abundant, remains spread on the free surface, or forms itself into a collection in the most dependent parts of the cavity. The chronic phlegmasiæ, sometimes, convert portions of the serous tissue into the fibrous, cartilaginous and the osseous, which are ordinarily observed under the

form of layers, either on the adherent surface or in the thickness of the membrane. The serous surface of the pericardium often presents examples of this kind. Concretions of the same nature as the preceding, either pedunculous or entirely unconnected, are sometimes found in the serous cavities, and especially in the synovial. Tubercles also occur sometimes in this system.

The formation of the accidental serous membranes, known under the name of *cysts*, is generally owing to a sub-inflammation, or at least to a constant irritation of the cellular tissue. These cysts, which have been demonstrated by Bichat to be analagous to the serous membranes, mostly result from the condensation of the cellular tissue around an effusion of blood, a collection of matter, serum, foreign bodies, &c. &c. Some are owing to the development of a pre-existing sac, such are the cysts which result from the dilatation of the ovarian vesicles, and of the spermatic cord, produced by the partial distention of the tunica vaginalis testis, &c. These cysts may present all the grades of organization of the serous membranes, and all the alterations to which they are subject: they exhale and absorb the same fluids. *Hydatids* are a kind of cysts which are distinguished from the others in this, that they do not adhere to the neighbouring parts. They are found in greater or less numbers in some organs, such as the brain, the liver, the uterus, &c. In the serous membranes, and the true cysts, they are filled and surrounded with serum, and appear to result from the organization of this fluid:—the consistency of their parietes resembles concrete albumen. These productions have been placed amongst the *entozoaria*, by M. Laennec, who has described them under the name of *acephalocystes*, while Cuvier, Rudolphi and Meckel have denied them a place in their zoological table.

The accumulation of serum in the cavities of the serous membranes—a kind of affection which constitutes dropsy,

is owing to a want of equilibrium between the exhalation and absorption of this fluid. The first exceeds its ordinary type, and constitutes what is termed *active dropsy;* it depends most frequently on inflammation, which may be either ephemeral or chronic: when the exhalation remains normal and the absorption is languid, it is called *passive* dropsy, and often results from a disorder of the circulation and an engorgement of the venous system,—a frequent consequence of some deep-seated alteration of some of the viscera.

SECTION 2.

Of the Sero-Splanchnic Membranes.

Definition.—The sero-splanchnic membranes are those which line the visceral cavities, and cover more or less completely the organs that are contained within them.

Division.—The sero-splanchnic membranes are divided into two classes; the first comprehends the tunica arachnoides, the pericardium, and the peritoneum; the second consists of the two pleuræ, and the two tunicæ vaginales of the testes.

General conformation and arrangement.—These, like the other serous membranes, form shut sacs;* and in their general arrangement they resemble "those night caps which are folded within themselves," in such a manner as to form an external and an internal lamina, which are continuous where they are reflected the one upon the other, and contiguous by one of their surfaces. The external or parietal lamina adheres to the parietes of the splanchnic cavity; while the internal or visceral lamina is spread upon the organs contained within it, and envelops them more or less complete-

* It must not be forgotten that the peritoneum forms an exception to this general character of the serous membranes, by the fallopian tubes penetrating into its cavity.

ly. It is in this sense that we distinguish the pleura costalis from the pleura pulmonalis, though they both form really but one serous membrane in each lateral half of the chest. The arrangement of the external layer of these membranes presents nothing remarkable; while that of the internal is more complicated, especially in the tunica arachnoides, and the peritoneum; the first furnishing a sheath to the encephalic blood-vessels and nerves, and the second being in connexion with the various organs of the abdomen and pelvis. The parietal layer is sometimes suddenly reflected to form the visceral, and to cover an organ that it does not ordinarily envelop completely, as for instance, in the ascending and descending portions of the colon. Sometimes, also, the membrane leaves the wall of the cavity, runs a short distance before it covers the organ to which it is sent, then envelops it completely, except where its blood-vessels and nerves enter, lines these, and regains the point where it was given off. From this arrangement result a number of folds, which derive their names from the organs with which they are in contact, &c. The visceral layer differs considerably in its arrangement from the preceding; after having covered a part of an organ, it is extended to the parietal layer, then is reflected on itself, and envelops the other portion. The folds which are formed by the visceral layer are either loose and floating, as the omentum, or maintained firmly in their situation by the continuity of their lateral parts with the parietal layer, as is the case with the broad ligaments of the uterus. In general, the layers of the duplicatures to which we have just alluded, are connected by loose cellular tissue to permit their separation, when the organ to which they correspond increases in volume.

Surfaces.—The external surface is every where adherent to the parietes of the splanchnic cavities, to the different viscera, to their blood-vessels and nerves, and to itself in the folds of which we have just spoken: the tunica arachnoides

affords the only example, and that only in a small part of its extent, where the external surface of a serous membrane does not adhere. We have already pointed the manner in which the serous membranes are connected to the different parts which they cover, and we have only to add, that their union is less firm and intimate where the parietal layer is reflected upon the organs. With regard to their free surface, we have nothing to add to what was said in the preceding section.

Texture.—The sero-splanchnic membranes are really nothing but large meshes of cellular tissue, modified with regard to its density. Their fibrous appearance is not so well marked, nor are they so abundantly supplied with pellucid vessels, as the synovial membranes. No nerves can be traced into them, and the red vessels which appear to penetrate them, belong to the subjacent parts, and are particularly numerous between their duplicatures, where there is also more or less adipose tissue.

Physical and vital properties.—The extensibility of the sero-splanchnic membranes is greater than that of the synovial, but their other physical properties and their vitality present nothing peculiar.

Functions.—In the healthy state, the quantity of fluid which is exhaled on the free surface of the sero-splanchnic membranes, is so small that it merely moistens them. It is composed principally of albumen, and when exposed to a slightly elevated temperature, most of it coagulates; according to the experiments of Béclard the incoagulable part consists of gelatinous mucus. The sero-splanchnic membranes serve to insulate the viscera from each other and the splanchnic parietes, at the same time that they facilitate their reciprocal motions by the polish and smoothness of their free surface. They also strengthen and protect a great number of blood-vessels in the visceral cavities by giving them an additional sheath, and line most of the membraniform organs.

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The form of these membranes, as well as their relations with the neighbouring organs, are frequently altered by collections of serum. These alterations are also sometimes owing to displacements of the viscera, particularly to those which result from herniæ—a kind of affection to which all the organs of the abdomen, and especially the intestinal canal, are subject. The organ that passes out of the splanchnic cavity, being generally covered by a layer of serous membrane, pushes with it a portion of the parietal sac which is placed before the opening through which it escapes, and which furnishes thus a second envelope that is contiguous to the first, and constitutes the *herniary sac.* This sac is often formed by the distention of the parietal layer—as in cases of umbilical herniæ.—The alterations of texture of the sero-splanchnic membranes having already been pointed out in the preceding section, it is only necessary to add, that they are more frequent in these than in the synovial membranes.

SECTION 3.

Of the Synovial Membranes.

Definition.—The synovial membranes are those which line the surfaces of the articular cartilages, and are interposed between the surfaces that move upon each other in the different parts of the body.

Division.—These membranes are divided into the subcutaneous bursæ mucosæ, the synovial membranes of the tendons, and those of the articulations.

Form and arrangement of the subcut. bursæ mucosæ. —The subcutaneous bursæ mucosæ are small spherical bags, which are interposed between the skin and certain osseous parts or cartilaginous projections. They are of different sizes and firmness, and are connected to the sur-

rounding parts by cellular substance; they often communicate with the tendinous capsules; are contiguous to themselves by their internal surface; and some of them are divided into several cavities by septa, which are more or less complete.*

Form and arrangement of the synovial membranes of the tendons.—The synovial membranes of the tendons may be arranged under two classes, the *spherical* and the *vaginal*. The spherical are placed most frequently between the tendons of muscles, and between the tendons and some of the bones, &c. They embrace these organs more or less completely, and are very intimately connected to them by their external surface, which often communicates with the subcutaneous bursæ, or the synovial membranes of the joints. Within some of these bursæ are small folds with fimbriæ appended to them, and covered by a continuation of the internal membrane of the bursæ. The vaginal bursæ, so called from their forming complete sheaths around the tendons, consist of two cylindrical membranes, which are continuous at their two extremities, and are connected to the surrounding parts by cellular substance. In some regions, one of the extremities of these tendinous sheaths is divided into several portions in the form of small bands, which are continued upon different tendons.

Form and arrangement of the synovial membranes of the articulations.—These membranes form shut sacs of the finest texture, are of a spherical form, and line the surfaces of the diarthrodial joints, their ligaments, and the parts which immediately surround them. Their number, form and arrangement, differ in the different joints; thus in some of the articulations, such as the ileo-femoral, the synovial capsule is reflected upon the inter-articular liga-

* To Béclard is due the honour of having given the first good description of these small organs.

ment, which gives it a kind of vaginal appearance. In the knee-joint, its reflections are still more complicated on account of the great number of ligaments, and the tendons to which it furnishes more or less complete sheaths. The synovial membranes adhere to the ligaments and periosteum, which they cover in such a manner that they can not be separated without difficulty: and their connexion with the articular cartilages is so intimate that they scarcely admit of being detached; so that several anatomists, and amongst others, M. Magendie, have denied its existence in the central portions of the cartilages; but a careful examination, as well as facts derived from pathological anatomy, such particularly as pseudo-membranous adhesions on the centre of the articular surfaces, will at once convince us of the incorrectness of the opinions of those who would deny its existence. The synovial membranes of the joints have loose folds which are analagous to those of the sero-splanchnic membranes, and are called *fimbriated prolongations.* These duplicatures contain cellular tissue and blood-vessels, as well as small masses of fat, which Havers improperly described as glands, and which have been named by his successors in honour of him, *glandulæ Haveri.*

Texture.—The tissue of the synovial membranes, especially that of the first two varieties, can be distinguished from the cellular tissue only by its greater density. Some of the synovial membranes of the joints appear to have lymphatic vessels; but no nerves can be traced into any of them, and their vessels, which do not carry red blood in the healthy state, can be seen only when they are inflamed.

Characters and physical properties.—All the synovial membranes are whitish, semi-transparent, soft and thin; and their sensibility appears to be less than that of the sero-splanchnic membranes.

Vital properties.—The vitality of the synovial mem-

branes, like that of the other serous membranes, is rendered evident only by inflammation.

Differences according to age.—The subcutaneous bursæ can easily be distinguished at the period of birth; their synovia being then more abundant than at any other period of life. Their extent and density augment, in proportion as the parts where they are found are exercised. According to the observations of Béclard, Bogros, Breschet, and Villermé, the synovial membranes of the tendons are developed subsequently to the friction of the tendons of the neighbouring parts. They are formed, indeed, in every part where the skin becomes the seat of habitual pressure, as for instance, in the stumps of amputated limbs. Sœmmering observes, that the bursæ diminish in number as we advance in life, by uniting with those with which they are contiguous. Finally, the synovial membranes, very fine and delicate in the fœtus and infant, become more dense and compact in the adult; in old age, they acquire a certain degree of rigidity, exhale less synovial fluid, are dry, and contribute not a little by the state in which they are, to the slowness of motion which marks this period of life.

Functions.—The synovial membranes serve to facilitate the reciprocal motions of the parts between which they are situated, both by the smoothness of their surface, and the presence of the synovial fluid, which is constantly exhaled and absorbed. This fluid is more abundant on the fimbriated prolongations, and is derived from the numerous blood vessels which are distributed between the reflections of these membranes, and not, as was said by Havers, from the elaboration of a glandular apparatus. The synovial fluid exudes from every part of the free surface of the synovial membranes—a fact, which in itself is sufficient to overthrow the hypothesis of Havers.—It differs both in quantity and properties in the different kinds of synovial membranes. In the bursæ mucosæ it is merely sufficient

to lubricate the membrane, and to render it unctuous to the touch; in the tendinous pouches, it is more abundant, of a thick viscid consistence, and of a yellowish red tint, composed of albumen and mucus. In the articular membranes it is equally viscid and ropy, of a saline taste, composed of water, albumen, fibrin, mucus, of some of the salts of soda and lime, and, according to the analysis of Fourcroy, of a small quantity of uric acid.

Pathological Anatomy.

Dropsy of the subcutaneous bursæ, (*hygroma*), and of the synovial sheaths of the tendons (*ganglion*) is by no means a rare disease; while that of the articular synovial membranes (*hydrarthrosis*) is seldom found to occur. The synovial fluid sometimes accumulates in considerable quantities, and preserves its normal character: at others, it is altered in various ways. In the first two varieties, it frequently resembles currant-jelly, both in colour and consistence. Inflammation of the synovial membranes often terminates by the secretion of puriform, or purulent matter, produces ulceration, or fungous growths, and converts the articular capsules into a gray striated, pultaceous substance, which gradually invades the whole joint. It also sometimes terminates in a thickening of the membranes, and in the formation of pseudo-membranous adhesions, which vary in form like those of the other serous membranes. Sometimes there are small bands, or cords, which, by their number and direction, represent a kind of cellular appearance; at others, there are membraniform layers which unite the free and contiguous surfaces, and produce permanent adhesions. All these affections impede the motions of the parts between which the membrane is interposed, and constitute a variety of *false anchylosis*—a disease which also frequently results from a thickening and induration of the articular synovial membrane and the adjacent tissues. When the contiguous parts of a joint adhere, the synovial

capsule and the articular cartilages are gradually absorbed; the extremity of the bones unite, and constitute what is termed *true anchylosis*. Foreign bodies, such as cartilaginous concretions, &c., are not unfrequent in the synovial membranes, especially in those of the tendons, which also, now and then, contain small bodies of the size and shape of a pear-seed, which have been falsely supposed to be endowed with life.—The synovial membranes of the joints are sometimes subject to fibrous, cartilaginous, and osseous concretions, which are either loose, or adherent, or lodged in the thickness of the articular cartilage;—saline concretions, composed principally of the urate of soda, are sometimes found in the articulations; and under certain circumstances new synovial membranes are formed, especially between the fragments of a broken and disunited bone.

Bibliography of the Serous System.

1. Sero-splanchnic system.

Bichat. Traité des Membranes. Paris, an VIII; pag. 73; III, 202—292.

——— Anatomie générale, tom. IV, pag. 108 et suiv. édit. citée.

J. F. Meckel. Ouv. cit.

P. A. Béclard. Ouv. cit.

Bonn. De continuationibus membranorum. Amst. Batav., 1763.

Langenbeck. Commentarium de structura peritonii, etc. cum tabulis. Gottingen, 1817.

2. *Synovial System.*

Fourcroy. Six Mémoires pour servir á l'Hist. anatom. des Tendons, dans lesquels on s'occupe spécialement de leur caps. muq.; dans les Mémoires de l'Acad. royale des Sciences. Paris, 1785—88.

Koch et Eysold. De bursis tendinum mucosis. Wittenburg. 1789.

Ch. M. Rosenmuller. Icones et descript. bursar. mucos. corp. hum. Leipsig, 1799.

A. Hávers. Osteologia nova. Londres, 1691.

Brodie. Traité des maladies des Articulations. Paris, 1819.

Margueron. Annales de Chimie, tom. IV.

J. Cloquet. Notes sur les Ganglions. (Arch. génér. de mèd., tom. IV, pag. 232.)

CHAPTER IV.

OF THE FIBROUS SYSTEM.

FIRST DIVISION.

OF THE FIBROUS SYSTEM, PROPERLY SO CALLED.

SECTION I.

General Observations.

Synonyma: Albugineous tissue, tendinous tissue, aponeurotic tissue, ligamentous tissue.

Definition.—The fibrous system consists of an assemblage of organs, which present various forms, serve different purposes, but are all composed of a white shining tissue, which is firm and strong, and consists of more or less distinct fibres.

Division.—The fibrous tissue, may be distinguished into several classes: 1st, into the *fibrous ligamentous organs,* which comprehend the tendons and the ligaments properly so called; 2d, into the *fibrous envelopes,* which consists of the aponeuroses of the muscles, the periosteum of the bones, the perichondrium of the cartilages, the dura mater of the brain, the sclerotica of the eye, the tunica albuginea of the testis, the glandular coverings, &c. &c.

General conformation.—There are two principal forms in the fibrous system, the fascicular and the membranous; the first belongs exclusively to the tendons and the ligaments; the second to the fibrous envelopes, and in part, also

to the ligaments and tendons. From the fact, that the tendons, the ligaments and aponeuroses, as well as the dura mater, and the fibrous envelope of the corpora cavernosa, are connected with the periosteum, Bichat has represented this membrane as the basis of the fibrous organs; but as some of the glandular envelopes, which belong, like the preceding organs, to the fibrous system, have no relation of continuity with it, we are not warranted in admitting this distinction.

Texture.—All the fibrous organs are composed of an assemblage of fibres, which are more distinct in some parts than in others; they are either disposed in fasciculi which are almost parallel with each other, or they are interwoven in different ways, and form thin and cross layers, as in the aponeuroses. These fibres consist of white filaments which are more fine and delicate than hairs, and enjoy all the physical properties which belong to the tissue which they compose. In his classification of the elementary tissues, M. Chaussier has applied the name of *albugineous fibre* to the tissue of which we are treating; but most physiologists of the present day, consider it as merely a very condensed variety of the cellular tissue. This tissue surrounds and connects every fasciculus, every fibre, and furnishes a sheath, or covering to the organs which they form. No nerves have as yet been traced into the fibrous tissue; it contains but little adipose substance, and its degree of vascularity differs in the different classes of fibrous organs; thus the periosteum and the dura mater are abundantly supplied with blood-vessels, while some of the tendons, especially the large ones, appear to be destitute of them. There are some, which receive lymphatics.

Characters, physical and chemical properties.—The fibrous tissue is of a brilliant white, argentine colour, firm and resisting, and stretched with difficulty. When this, however, takes place suddenly, the cause of resistance is sometimes overcome, and the organ is torn; often, howev-

er, this resistance is greater than that of the bones &c., to which it is attached. The fibrous tissue, having but little extensibility, is sometimes subject to accidents, known under the name of *strangulations*, which consist in the insuperable obstacle which the fibrous organs present to the development of the parts which are ordinarily surrounded by them, and whose volume is suddenly augmented by violent inflammation or other causes. It possesses but little elasticity, at least in its fresh state; it retracts with a degree of slowness proportionate to that of its distention. By desication, it becomes somewhat elastic, transparent, of a yellowish red colour, and almost homogeneous; but by submitting it to the action of water, for a short time, it recovers all its original characters. After long maceration, its fibres separate, and are changed into a soft, whitish pulp, which, by the action of ebullition, is resolved into gelatine. It is very difficult of digestion, and when exposed to putrefaction, it resists its action for a considerable time.

Vital properties.—In the healthy state, the sensibility of the fibrous tissue, as we have already seen, is rendered evident by violent distentions, such as sprains, which produce excessive pain, and often give rise to the most intense inflammation.* Nevertheless, if a fibrous organ be punctured, divided, or submitted to the action of chemical irritants, the animal will not evince the least symptom of pain: though sometimes, these causes may be capable of acting upon this tissue in such a manner as to excite inflammation. The fibrous tissue is destitute of contractility of texture; and when injured, it is often readily repaired.

Mode of development, and differences according to age.—The fibrous tissue can be distinguished about three months after impregnation: in the infant, it is of a pearly,

* Many persons, and we amongst the rest, believe, contrary to the generally received opinion, that this pain ought to be attributed rather to the nerves of the injured part, than to the ligaments themselves.

white appearance, and yields readily to the extensive motions which are performed at this period, and being more extensible, it breaks less easily. At this period, the periosteum, the dura mater, and the sclerotica, are comparatively more developed than in the subsequent periods of life. In old age, the fibrous tissue becomes more compact and inflexible, more yellow and less shining than in the adult. Notwithstanding its hardness, it seldom ossifies, except in those regions where it is exposed to the friction of the bones, or in the neighbourhood of the cartilages.

Functions.—The functions of the fibrous system vary in the different fibrous organs, and are all purely mechanical.

Pathological Anatomy.

When a fibrous organ has been extended, it becomes elongated and thickened, and with difficulty recovers its former state. Wounds of these organs heal by the effusion of adhesive matter which closes up their lips, and acquires the density of fibrous tissue. Inflammation seldom terminates in gangrene or suppuration, but most frequently by resolution or a thickening of the organ. The chronic phlegmasiæ of the fibrous organs often produce cartilaginous and osseous growths, the development of fungous polypi, and carcinomatous tumours. The fibrous tissue is sometimes accidentally developed around cysts, tumours, false anchyloses, and in the pseudo-membranous adhesions of the serous membranes. The cicatrices of the liver and the skin consist of a tissue analagous to the fibrous, and the development of some polypi and subcutaneous tumours, especially those that occur between the rectum and the vagina, and between it and the bladder, may also be referred to it. Fibrous bodies are also sometimes found in certain parts of the body, especially in the uterus and the ovaries, which are often confounded with schirrus, though they are entirely different. They are more or less numerous, are round and lobulated, small and soft, and gradually

increase in volume and density. They are formed of two layers; one of which is fibrous, the other of a homogeneous texture, and consists, according to the researches of J. F. Meckel, of fibro-cartilage. They are frequently organized, and are sometimes converted into cartilaginous and osseous substances: the calculi which occur in the uterus are often nothing but lobes of these bodies.

SECTION 2.

Of the Organs Composing the Fibrous System, Properly so Called.

ARTICLE 1.

Of the Fibrous Ligamentous Organs.

The fibrous ligamentous organs comprehend the ligaments of the bones and cartilages, and the tendons which unite the muscles to the hard parts.

§ 1. *Of the Ligaments.*

Definition.—Ligaments are strong fibrous organs, varying in form, and adhering to the bones or cartilages.

Division.—The ligaments are divided according to their situation: 1st, into *articular*, or those which are attached to the ends of the articulating bones; 2d, into *non-articular*, or those which pass from one part of a bone to another, either to convert a fissure into a foramen, as the coraco-acromion ligament of the scapula, or to obliterate an osseous aperture, as the sub-pubic ligament, for the purpose of giving origin to muscles; 3d, into *mixed*, or those which supply the place of bones, and increase the extent of surface for the attachment of muscles; as the inter-osseous peroneo-tibial, the radio-cubital, and the sacro-sciatic ligaments.

Conformation and arrangement.—All the different classes of ligaments have the two general forms of the fibrous organs, the fascicular and the membranous. The fascicular ligaments are generally of an irregular quadrilateral form, seldom triangular, composed of white fasciculi, arranged in parallel lines, and connected by cross fibres. The articular ligaments are termed external or internal, accordingly as they are situated in relation to the joint. Most of the external ligaments are situated laterally, and in such a manner as to confine or prevent lateral motion; internally they adhere to the synovial membrane, externally to the tendons, &c. which surround the joint. The internal ligaments are white fibrous cords, which are situated within the knee and the ilio-femoral articulation, and are attached by their extremities to the centre of the articular surface, and adhering in the rest of their extent to the synovial membrane, which is reflected upon them so as to form a sheath. The membranous ligaments vary in form, and are composed of distinct fasciculi, which are more or less intimately connected with the periosteum. The capsular ligaments form large fibrous sacs, which surround some of the moveable joints, and are attached by each of their extremities to the circumference of the osseous parts, which enter into the composition of the joints. They adhere firmly by their internal surface to the external surface of the synovial membrane, and by the other, to the peri-articular tissues.

In infancy, the ligaments are almost exclusively inserted into the periosteum, and their connexion with the bones and cartilages is loose and feeble, while it becomes more firm as we advance in years, and extremely intimate in old age.

Texture.—The ligaments are of a firm compact texture, of a yellowish colour, and composed of fibres which are more distinct in some than in others. They receive blood-vessels and lymphatics, and have a small quantity of fat,

which it is difficult to distinguish at first sight. They possess but a small share of elasticity and sensibility, though according to some anatomists, nerves may be traced into their substance.

Functions.—The functions of the ligaments differ in the different classes of ligaments; thus the articular ligaments connect the extremities of the moveable bones, while the non-articular and mixed serve to convert certain bony fissures into foraminæ, and to increase the extent of surface for the attachment of muscles, &c.

Alterations.—The ligaments, especially the capsular, are often ruptured,—inflamed,—relaxed,—thickened,—reduced to a lardaceous spongy substance, and ossified.

§ 2. *Of the Tendons.*

Definition.—The tendons are the fibrous, ligamentous organs, which unite the muscles to the bones or cartilages, or even two portions of the same muscle.

Division.—They are divided according to their form, into *funicular* and *aponeurotic* tendons.

Situation and relations.—The tendons are most commonly situated at the extremities of the muscles, and are connected to them by one extremity, and by the other to the bones, or the aponeurotic envelopes. The tendons sometimes interrupt the continuity of the fleshy fibres, and give the muscle a digastric appearance, &c. In some instances, the funicular and aponeurotic tendons occur on the same muscles, and when this is the case, the first is attached to the more moveable part, and the second to that which serves as the fixed point. The union of the tendons with the fleshy fibres is every where firm and intimate. In some places the muscular fibres run from both sides obliquely downwards or upwards, to a tendon in the middle of a muscle and form an arrangement analogous to the plumage of a feather; or the tendinous fibres follow the direction of

the muscular, with which they appear to be continuous. In some instances the tendons are more or less completely surrounded by synovial bursæ; are contained in fibrous sheaths, and are in relation with loose cellular tissue.

Conformation.—The funicular tendons are elongated, rounded or flattened cords, some being single in their whole extent, others divided at one of their extremities into several distinct portions. The aponeurotic tendons, like the funicular, are either single or divided; in some instances they form arches for the passage of blood-vessels and nerves, and are inserted by their extremities into the bones; others are partly funicular, and partly membraniform. In some instances the muscles terminate in very short, separate fasciculi, which are connected to one or the other kind of tendons to which we have just alluded.

Texture.—The tendons are of a firm compact texture, are composed of condensed cellular tissue, and their fibres, which are white and small, are intimately united to each other by cellular tissue. They have but few blood-vessels, and neither nerves nor lymphatic vessels have been traced into their substance.

Characters, physical and vital properties.—The tendons are of a pearly white appearance, dry, tough, and inextensible; their vitality, especially that of the funicular, appears to be less than that of the other fibrous organs.

Functions.—The tendons serve to unite the muscles to the bones and cartilages, and, by affording a more extensive surface of insertion to the muscular fibres, to facilitate their action.

Alterations.—The tendons are seldom inflamed; but when they are bruised or otherwise injured, they become affected with indolent swellings, which continue for a long time. They participate in the softing of the ligaments in cases of white swelling, and when exposed to the air and deprived of their cellular tissue, they mortify and exfoliate.

ARTICLE 2.

Of the Fibrous Envelopes.

The fibrous envelopes comprehend: 1st, the aponeuroses, or fibrous envelopes of the muscles; 2d, the sheaths of the tendons; 3d, the periosteum; 4th, the perichondrium; 5th, the dura mater, the sclerotica, albuginea, &c. &c.

§ 1. *Aponeurotic Envelopes.*

Definition.—The aponeuroses are fibrous membranes which cover more or less completely one or more muscles.

Division.—They are divided into general and partial; the first belong to the extremities, the second to the trunk.

Conformation and arrangement.—The *general envelopes* represent the form of the extremities whose muscles they surround. By their internal surface they are in contact with the muscles, and send membranous elongations between them, which, in separating them from each other, furnish points of attachment to some of their fibres, and go to be inserted into osseous eminences. The external surface is united by loose cellular substance to the teguments, the adipose tissue, and the subcutaneous vessels. At their extremities, the general aponeuroses are confounded with the periosteum or cellular tissue, and form fibrous rings for the passage of tendons. The *partial aponeuroses* vary in form, and serve to envelop but incompletely the muscles of the parietes of the splanchnic cavities. There are some which cover but one muscle, as the temporal, while others envelop several; some correspond by their internal surface to the muscles which they cover, and by the external to the subcutaneous cellular tissue: others are in contact with the muscles on both surfaces, and consist of several layers which contain these muscles

between them, as in a kind of pouch; an example of which is seen in the aponeuroses of the recti muscles of the abdomen.

The aponeuroses have generally one or more tensor muscles that are inserted into them, either in whole or in part, which are destined to give them a degree of tension or relaxation proportioned to the state of the surrounding muscles. This arrangement is remarkable in the insertion of the tensor vaginæ femoris into the fascia lata of the thigh; of the biceps brachialis into the anti-brachial aponeurosis, &c.

Texture.—The aponeurotic envelopes are composed of one or more layers of fibres, which pass in various directions.

Physical characters.—The aponeurotic envelopes are of a pearly white appearance; their thickness is in direct ratio with the number, force and activity of the muscles which they envelop. Their fibres are more inflexible and resisting than those of the tendons, and yield less readily to maceration and the action of ebullition.

Functions.—The aponeuroses serve to maintain the subjacent parts in their natural situation; to cover and insulate the muscles; to facititate the circulation of the venous and lymphatic fluids, and, by their want of extensibility, to prevent their accumulation.

§ 2. *Of the Tendinous Sheaths.*

Definition.—The tendinous sheaths are the expansions of the fibrous tissue, which form, either alone, or in conjunction with the neighbouring parts, a kind of canal for the passage of one or more tendons.

Division.—The tendinous sheaths are divided into general or partial, according to the number of tendons which they receive.

Situation.—The tendinous sheaths are seen principally in the extremities, especially in the sense of flexion—a dif-

ference which is owing to the number of flexor muscles being greater than that of the extensors. Thus, besides the strong sheath which the flexors of the fingers have in common with each other, each of them receives a proper one, while the extensors are maintained in their proper place merely by some of the tendinous fibres of the interoseous muscles.

Form and arrangement.—The sheaths of the tendons are so arranged, that some of them form complete canals for the passage of the tendons, while others form only a part, the other part being formed by the bones which give insertion to the extremities of the tendinous sheaths. In some instances, they form true canals, while others constitute only a kind of rings, and are hence called *annular ligaments.* When these sheaths receive more than one tendon, they are either simple or compound, that is, they are divided by fibrous prolongations into as many canals as there are tendons. They are continuous with the aponeuroses of the extremities where they are found. Their internal surface is lined by a vaginal synovial pouch, which, in the compound sheaths, sends reflections between the tendons, so as to form more or less complete septa.

Texture.—The tendinous sheaths are of a very dense and compact texture, and are composed of transverse or oblique fibres, which are more apparent in some than in other places.

Functions.—They give strength and firmness to the tendons, maintain them in their proper situation, and direct their force.

§ 3. *Of the Periosteum.*

Definition.—The periosteum is the fibrous envelope of the bones.

Form and arrangement.—This membrane represents the form of the bones which it surrounds and covers. It is wanting on the cartilaginous surfaces of the moveable

joints where its continuity is of course interrupted; in the immoveable articulations it passes without interruption from one bone to the other.—In infancy it is thick, and can be easily separated from the bones; while in the adult it is more firm and compact, and is intimately connected with the short bones and the extremities of the long ones, and, in short, every where, where they present a spongy texture. The periosteum gives off numerous prolongations which accompany the vessels that enter every where the spongy substance of the bones.

Texture.—The direction of the fibres of the periosteum is analogous to that of the long and the short bones; but its arrangement is different in the flat bones. It receives a great number of blood-vessels, and some lymphatics; and when subjected to continued pressure, it is converted into a fibro-cartilaginous substance.

Differences according to age.—In the fœtus, the periosteum is soft and spongy, moistened by a gelatinous fluid, and possessed of but little vascularity. As we advance in years, its fibres become more distinct, and the membrane increases in firmness, consistence, and vascularity; in old age, it has extreme tenacity, and even becomes ossified on its internal surface.

Functions.—The periosteum defends the bones which it covers from the impression of the organs that move upon its surface, and strengthens the parietes of their vessels. In infancy, it unites the epiphyses to the bodies of the bones, and serves for the insertion of the ligaments and tendons, which subsequently and in consequence of the ossification of this membrane at their points of attachment, adhere to the bone itself.

Pathological Anatomy.

Wounds of the periosteum are followed by a cicatrix which resembles it in texture, and when a small portion of it has been raised or detached, it is generally reproduced.

Inflammation of this membrane seldom terminates in gangrene, but most frequently in suppuration, which detaches it from the bone, and has a tendency to produce periostosis, osssification, soft cancer, and the development of fungous growths.

§ 4. *Perichondrium.*

The perichondrium is the fibrous membrane which covers the non-articular cartilages; it is less intimately connected to them, than the periosteum is to the bones, and does not send to them as many fibrous elongations. It contains fewer blood-vessels than the periosteum, has less vitality, and differs from it also in some of the characters which we have just pointed out.

§ 5. *Of the fibrous envelopes of the brain, the spinal marrow, and some other organs.*

These membranes are, 1st. The dura mater, (meninx of Chaussier), a very dense, and vascular membrane, composed of tendinous-like fibres, running in various directions, and situated within the cranium and the vertebral canal, to the former of which it forms an internal peri-cranium. It is intimately united with the tunica arachnoides, covers the brain and spinal marrow, and sends elongations in the form of sheaths upon the nerves which pass out at the base of the cranium, and through the vertebral holes. This membrane forms a number of folds or duplicatures within the cavity of the cranium, which may be distinguished into those which separate the different parts of the brain, as the falx major, the tentorium cerebelli, and the falx minor; and into the sinuses of the dura mater, or those which perform the offices of veins, and are lined by a continuation of the internal membrane of the veins.

2d. The sclerotica, an opake, white, elastic, fibrous membrane, of unequal thickness, possessed of little vascu-

larity, and serving as a covering to the eye, determining its shape and supporting and defending the more delicate and useful parts within it.

3d. The tunica albuginea, a strong, dense, in-elastic membrane, varying in thickness, possessed of but little vascularity, and serving to surround and defend the testes. —Under this head may also be included the *fibrous* envelopes of the ovaries.

4th, and lastly, *the fibrous capsules of the kidneys*, which surround them, and send prolongations into the interior of their substance.

It remains to be remarked, that none of the organs which are surrounded by coverings of the non-elastic fibrous tissue, are destined to undergo any temporary changes of volume, as are those which are surrounded and enveloped by the elastic fibrous tissue.

§ 6. *Of the fibro-serous and the fibro-mucous membranes.*

Every where, where the fibrous membranes are found in relation with the serous or the mucous, they are so firmly united to them, that it is impossible to separate them by dissection; so that they appear to form a single membrane, fibrous on its external, and mucous or serous on its internal surface. The pericardium and the tunica vaginalis, are, in a part of their extent, true fibro-serous membranes; the union of the dura-mater and the arachnoides is also very intimate every where, where these envelopes are applied, the one upon the other. We see examples of the fibro-mucous membranes in the trachea, where the fibrous tunic is inseparably united with the mucous; in the periosteum and perichondrium, wherever the internal teguments lie immediately upon them, as in the nasal fossæ, the meatus auditorius externus, the larynx, &c.

SECOND DIVISION.

Yellow elastic fibrous System.

Definition.—This system comprehends a great number of membranous, ligamentous parts, &c., formed of a tissue analogous to the preceding in texture, but differing from it by its great elasticity.

Situation.—This tissue is found in every part of the body, where it is necessary that there should be a continual or intermittent resistance to the impression of weight, to the action of the muscles, &c. In the human subject, the principal organs in which this tissue occurs, are, the yellow ligaments of the vertebræ, the proper coats of the vessels, especially those of the arteries, the excretory and æreal ducts, the covering of the spleen, and of the corpora cavernosa.*

Conformation.—The fibrous elastic tissue is found under three forms; 1st, under that of fasciculi, as in the yellow ligaments; 2d, under that of tubes, as in the vessels and excretory ducts; and 3d, under that of membranous capsules, with interior reticular elongations, as in the coverings of the spleen, and the corpora cavernosa.

Structure.—This tissue is formed of fibrous fasciculi, parallel with each other, or nearly so, but never interlaced, and easily separable; it contains little cellular substance and but few vessels.

Characters, physical and chemical properties.—In the living subject, the elastic fibrous tissue is firm and opake, and of a white yellowish colour, which becomes more distinct after death; it has less tenacity, and more extensibility than the other fibrous tissue, is more tenacious than the

* In quadrupeds, this tissue constitutes the ligamentum nuchæ, or the posterior cervical ligament, and the ligament which is inserted into the claws of some of the feline species.

muscular, in the dead than the living subject, and bears a greater resemblance to it, than the preceding tissue. It contains a great quantity of water, upon which depends its most remarkable physical property—elasticity—by virtue of which, it immediately recovers its original state, when it has been distended or compressed. When this tissue is dried, it loses half its weight, and assumes a corneous appearance, but a few days maceration is sufficient to recover its elasticity and original characters.

The yellow fibrous tissue resists for a long time the action of boiling water, the acids and alkalies; and maceration scarcely produces any alterations.—It is composed principally of albumen and fibrin.

Vital properties.—This tissue appears to have neither sensibility nor contractility.

Functions.—The yellow fibrous tissue serves the purpose of ligaments or envelopes to certain organs, yields by its extensibility to their changes of volume or situation, and recovers its natural form as soon as the cause, which induces these changes, has ceased to act.

Pathological Anatomy.—The anatomical history of the diseases of this tissue, having been included under that of the fibrous tissue, properly so called, we shall only remark here, that this tissue very seldom ossifies, and that it has a tendency to lose its elasticity from too frequent, excessive, or continued distention.

THIRD DIVISION.

Fibro-cartilaginous System.

Definition.—This system comprehends those organs, which, by their texture and tenacity, participate in the characters of the fibrous tissue, and by their density and whiteness in those of the cartilages.*

* Bichat has placed in this system the membraniform cartilages which

Division.—The fibro-cartilaginous organs are distinguished; 1st, into the inter-articular, or those which are free on both surfaces; 2d, into those which have one surface free and the other adherent; these are the fibro-cartilages of the tendinous sheaths and of the circumference of the articular cavities; 3d, into those, which adhere by their two surfaces to the bones to which they serve as a bond of union.

Situation, conformation, and arrangement.—1. The inter-articular fibro-cartilages, are situated in the articulations of the knee, the inferior maxillæ, and the clavicle. They are lamelliform, free on their surfaces, connected by their borders to the synovial capsules or the articular cartilages, and sufficiently moveable to adapt themselves to the motions of the joints in which they are placed; 2, The fibro-cartilages, adhering by one of their surfaces, consist, 1st, of those of the tendinous sheaths, which facilitate the gliding of the tendons, and protect them from the impression of the bones; and 2d, of those which surround the glenoid and cotyloid cavities; 3, The fibro-cartilages which are adherent by their two faces, are placed between the surfaces of the bones, to which they serve as bonds of union: these vary in form, being circular in those which connect the bodies of the vertebræ, almost quadrilateral between the symphysis pubis, &c.

Structure.—The fibrous and cartilaginous tissues are not combined in the same proportion, nor disposed in the same manner in every part of the fibro-cartilaginous system, nor every where in the same fibro-cartilage. Thus, the fibrous substance predominates in the inter-vertebral ligaments, where it forms concentric layers; it is less abundant, and consists of circular fibres where it surrounds the

are regarded by Meckel, Bèclard and other anatomists, as true cartilages. We shall see in the following chapter, that this manner of observing the membraniform cartilages is preferable to that of Bichat.

glenoid and cotyloid cavities; still less abundant in the inter-articular fibro cartilages, and often scarcely distinguishable in the sheaths of the tendons, where it is formed at the expense of the periosteum, which is almost entirely converted into cartilage. In general, the fibrous substance is more apparent in proportion as the fibro-cartilage is examined near its external surface; and the cartilaginous, in proportion as we approach nearer to the centre of an organ where the fibres disappear. In some instances there is alternately a layer of the fibrous tissue and one of the cartilaginous. The fibro-cartilaginous system, like the two of which it is composed, has but little vascularity.

Characters, physical and chemical properties.—The fibro-cartilages are of a whitish appearance, and unite to the tenacity of the fibrous system, the elasticity of the cartilages. It has been observed, that during pregnancy, the fibro-cartilages which unite the bones of the pelvis are sensibly softened, and become more humid. The fibro-cartilages resist, for a considerable time, the action of boiling water, but dissolve at last into gelatine.

Vital properties.—In the healthy state, the fibro-cartilages appear to have neither sensibility nor contractility.

Differences according to age.—In infancy, the fibro-cartilages are soft, and appear to be composed principally of a homogeneous substance, and as their consistency increases, their fibres become distinct, and more fully developed. They seldom ossify in old age.

Functions.—The fibro-cartilaginous organs differ in their uses in the different parts of the body: some facilitate the motions of the tendons, giving them a point of attachment at once solid and elastic; others favour the mobility of the articular surfaces between which they are situated, either as a kind of cushion, or as elastic ligaments.

Pathological Anatomy.

In consequence of their small degree of vitality, the

fibro-cartilages are seldom subject to diseases; when wounded, they inflame, and after a considerable time they cicatrize and heal. Inflammation of these organs is slow in its progress and is characterized by redness, which is either uniform or striated, and often passes to a brown colour; it often terminates in the effusion of a kind of ichorous matter, which is either deposited in their substance, or exhaled upon their external surface. They seldom ulcerate, though this has been observed to take place. In many ricketty subjects, and in some of those who suffer from mal-conformation of the vertebral column, the inter-vertebral fibro-cartilages tumify, and become softened and engorged with fluids. Amongst the preternatural fibro-cartilaginous productions, we may cite those which are developed in the fibrous tissue in consequence of accidental friction, and those which occur in some cysts, or in certain tumours, and cicatrices, as in tubercles of the lungs, and in many other fibrous bodies.

Bibliography of the fibrous System.

Besides the works already cited, the reader is referred particularly to the excellent articles by Béclard in his additions to the Anatomie Generale de Bichat, and to those in his own work, Chap. VII. (vas. sys.) p. 323, et seq. For an account of the pathological anatomy of the fibrous and fibro-cartilaginous systems, see l'Histoire Anatomique des Inflammations de M. le docteur Gendrin, p. 322, et seq., and the articles by Laennec, in Dictionnaire des Sciences Medicales; tome XV.

CHAPTER V.

CARTILAGINOUS SYSTEM.

SECTION 1.

General Observations.

Definition.—The cartilages, or the organs which compose this system, consist of hard whitish substances, somewhat flexible and elastic, having apparently neither texture nor organization, independent of each other, and generally in connexion with the osseous system.

Division.—The cartilages are divided into two great classes; into those which are temporary and those which are permanent. These last are again subdivided into two classes; the first comprehends the articular cartilages, or those which are not covered by the perichondrium; in the second are included all those which receive a covering from this membrane, viz. the membraniform cartilages, the cartilages of the ribs, the larynx, &c.

Conformation and relations.—The cartilaginous organs present a great variety of form; some are long and narrow, others thin and broad and spread out like a kind of membrane; all are more or less flattened. We shall enter more into detail with regard to their form in the following sections. The articular cartilages are firmly united to the articular extremity of the bones, either by their two surfaces, as in the synarthrodial joints, or by one only, as in the moveable articulations. Those of the second subdivi-

sion adhere to the bones, as those of the ribs, the ear, the nose, &c. or they are in relation with the soft parts, as those of the larynx, &c.

Texture.—At first sight, the cartilaginous tissue appears to be composed of a homogeneous substance, but upon a more minute examination, small fibres may be discovered, whose direction varies in the two subdivisions of the permanent cartilages, as we shall see when treating of each of them separately. When macerated for a long time in water, this tissue exhibits the appearance of a cellular network: no nerves can be traced into it; nor does it appear to have any blood-vessels, unless we consider as such the reddish or striated appearance which it sometimes exhibits. The cartilages are, nevertheless, penetrated by the fluids of the system; this fact, which the nutrition of these organs supposes, is rendered evident by the yellow colour with which they are tinged in some cases of jaundice.

Characters, physical and chemical properties.—The cartilages are of a pearly white colour, very elastic and smooth, and when divided into thin layers, they present the semi-transparency of horn; they are divisible by the scalpel, and are the only substances which are exceeded by the bones in hardness and density.* The cartilages may be greatly distended without rupture of their tissue; they contain a great quantity of water; when dried, they assume a transparent, yellowish colour; but upon exposing them to water for a short time, they recover their former aspect: a long time is required for their maceration, and when exposed to putrefaction, they yield to its action less readily than many other animal substances. When boiled, they become brittle and indented, and the articular ones are alone dissolved and converted into a kind of gelatine; while the others remain insoluble and afford no gelatine. Chemical analysis has hitherto afforded us no positive data with regard to the composition of the cartilages of the human subject. According to the experiments of

* Rather they are superior in hardness to the bones.

Hatchett and Davy, they are composed of albumen and phosphate of lime, and according to Mr. Allen, of albumen and a small proportion of carbonate of lime. Mr. Gendrin regards the gelatinous substance, obtained by boiling articular cartilages, as a compound of albumen, animal mucus and phosphate of lime; according to this author, the cartilages of the larynx contain gelatine, formed in great measure of fibrin in combination with water.

Vital properties.—The cartilages have little sensibility in their healthy state, and their vital action is very obscure: they are slowly developed, except at the period of puberty, when those of the larynx suddenly increase, and form one of the most remarkable characteristics of that age.

Differences according to age.—The cartilages have at first the appearance and consistence of thick mucilage; but they gradually increase in density, until they at length acquire their proper degree of solidity. In adult life, they are more elastic than at any other period; in old age, they become more dry, increase in colour and opacity; and sometimes, in consequence of the greater proportion of calcareous substance, they become hard and ossified either in part, or entirely. The cartilages of the diarthrodial joints are the only ones which are not subject to this transformation, which sometimes affects the others at a very early age.

Functions.—The use of the cartilages is to facilitate the motions of the bones, to connect them together, and to form the basis of certain parts, either in part or entirely.

Pathological Anatomy.

When the cartilages are divided without loss of substance, the surfaces of the solution of continuity remain in juxta-position, but do not contract adhesions, and the perichondrium alone, when it exists, cicatrizes and forms an osseous callus which closes up the wound. When detached from the surrounding tissues, they do not unite with them.

Inflammation of these organs, though not well characterized, sometimes terminates in ulceration, tumefaction, and softening, and the development of lardaceous productions, especially in some of the diseases of the joints. We shall speak more in detail concerning these alterations, when treating of the different kinds of cartilages.

In some instances, cartilages are accidentally developed in the animal economy: Mr. Laennec has divided them into *perfect* and *imperfect*—a division which has been rejected by Meckel, who made his observations at different periods of the development of similar productions. The accidental cartilages occur under the form of layers in the thickness of the parietes of the arteries, the subserous tissue of the spleen, the lungs, the testicles, &c.; in irregular masses in the substance of some organs, as the thyroid glands, the ovaries, &c., and finally, in some schirrous and lardaceous tumours under the form of small, flattened bodies, which are either attached or free on the exterior or in the interior of the synovial membranes, but seldom in the serous. The ureters, the vagina, and the prepuce, are all sometimes the seat of a cartilaginous transformation; and sometimes, though very seldom, even the bones themselves.

SECTION 2.

Articular Cartilages.

Definition.—The articular cartilages are those which cover the articular surfaces of the bones.

Division.—The articular cartilages are divided into the diarthrodial and synarthrodial, or into those of the moveable and immoveable articulations.

Conformation and arrangement.—(*a*) The diarthrodial cartilages are in the form of flattened lamellæ, which are more thin at the circumference than at the centre

of the convex articular surfaces; more thick, on the contrary, at their borders than at their centre on the concave articular extremities, spread upon the osseous diarthrodial surfaces, which they cover in every part of their extent, and to which they are firmly united by one of their surfaces, while the other is lined by the synovial capsule which separates it from the corresponding surface of the opposite articular cartilage. (*b*) In the immoveable joints, the articular cartilages are lamelliform, and adhere to the bones by their two surfaces, and to the periosteum by their borders.*

Texture.—By long maceration, the action of ebullition, &c., it can be satisfactorily shown that the tissue of the articular cartilages is of a homogeneous nature, and composed of fibres. These fibres are small, and are disposed perpendicularly on the osseous surface which they cover, and to which they are very intimately united; those of the diarthrodial cartilages appear to become soft at their free extremity, where the cellular tissue which enters into their composition is modified, so as to perform the office of the synovial capsule which lines the cartilage. The blood-vessels, nerves, and lymphatic vessels of the articular cartilages are so small as to elude observation, but there can be no doubt of their existence, as is clearly shown by the phenomena of disease.

Chemical characters.—The articular cartilages are the only ones that can be reduced into gelatine by the action of ebullition.

Differences according to age.—To what we have already said upon this subject in the preceding section, we may add that the diarthrodial cartilages become very sensibly thinner in old age, and that they ossify less readily

* The synarthrodial cartilages of the bones of the cranium are more thick on its convex surface than on its concave; so that the sutures are less distinguishable on the interior than on the exterior of that osseous vault.

and more seldom than any other; and that, on the contrary, those of the immoveable articulations belong rather to the class of temporary cartilages than to that of permanent.

Functions.—The articular cartilages counteract, by virtue of their elasticity, the efforts of compression and the shocks which are experienced by the articular surfaces; they facilitate, also, by virtue of the same property, the motions of the diarthrodial joints.

Pathological Anatomy.

In the phlegmasiæ of the joints, the articular cartilages are sometimes swollen and softened, so that their fibres become apparent on their interior as well as on their free surface, which assumes a velvety appearance. These cartilages, especially those of the diarthrodial articulations, are seldom subject to inflammation; sometimes, however, it takes place, and terminates in suppuration, in ulceration, and the destruction of the cartilage.* In some instances, the articular cartilages are replaced by a hard, ivory substance, which, according to Meckel, consists of the urate of soda.

It sometimes happens that the diarthrodial cartilages become thinner than natural—a phenomenon which Mr. Laennec has attributed to the incomplete reproduction of a part of a cartilage that has been destroyed by ulceration. The cartilaginous or osseous incrustations which are sometimes found in the articular cartilages, are new productions which enter the joint by traversing the synovial membrane, and are lodged in depressions of the cartilaginous layer. In the false articulations which are found between the two fragments of a broken bone, there is generally a tissue which is more or less analogous to that of the diarthrodial cartilages, but which ought to be considered merely as an imperfect callus.

* This destruction is followed by the union of the denuded surfaces of the bones which are then brought in contact, and constitute *true anchylosis.* (V. Path. Anat. of the Oss. Sys. p. 167.)

SECTION. 3.

Perichondroïdal Cartilages.

Definition.—The perichondroïdal cartilages are those which constitute the basis of certain organs, either in part or in whole; are covered by the perichondrium, and may be reduced into gelatine by the action of ebullition. These cartilages, are those of the ribs, the larynx, the auricular canal, the septum nasi; and those of the alæ nasi, the eye-lids, the pavilion of the ear, the tongue, the epiglottis, the trachea and bronchia, which Bichat has improperly arranged under the head of fibro-cartilages.

Form and connexions.—The perichondroïdal cartilages vary in form; some, as the thyroid, &c., are membraniform; others, as those of the ribs, are in the form of thick narrow bands; while others again, as those of the trachea and bronchia, represent incomplete rings. In some instances they adhere to the bones by their borders, or their extremities are intimately united to them like the articular cartilages, as the cartilages of the ribs, the septum nasi, &c., while others are in relation only with the soft parts, as those of the eye-lids, the larynx, and the trachea. Some of these cartilages, as those of the larynx, form true articulations, and are united together by ligamentous capsules.—For a more minute account of the form and connexions of these organs, the reader must consult the works on descriptive anatomy.

Texture.—(*a*) The costal cartilages consist of elliptical plates, united together by transverse fibres: according to Hérissant, they have a spiral arrangement. Whatever it may be, it is certain that they can be decomposed into fibres, and reduced finally to cellular tissue; but to analyze the texture of these cartilages, it is necessary to macerate them for a long time in water, followed by their desiccation or

the action of the acids. By maceration and ebullition, the other cartilages of this class may at first be reduced to short and very delicate fibres, and afterwards to cellular tissue. Those of the eye-lids, of the ear, and all the membraniform fibro-cartilages of Bichat are less dense, and offer less resistance to maceration, &c., than the other cartilages. They are covered by a thick perichondrium, which sends fibrous elongations into the interior of their substance, while the fibrous envelope of the preceding cartilages is united to them merely by cellular tissue.

Physical properties.—The perichondroïdal cartilages, especially the membraniform, are more or less flexible, and very elastic; they contain more earthy matter than the diarthrodial, and can not be resolved into gelatine by the action of boiling.

Differences according to age.—Some of the perichondroïdal cartilages, and especially those of the ribs, the larynx and the trachea, after they are fully developed, become hard, and ossified either in part, or in whole, and acquire a soft and spongy texture in their centre. In the costal cartilages, this normal transformation is accelerated by phthisis pulmonalis, and in the larygeal, by phthisis laryngitis.

Functions.—The cartilages, of which we are treating, constitute, either alone or in conjunction with the bones, the basis of certain parts of the body, determine their form, and perform the offices of bones wherever the movements of dilatation and contraction, &c., require an elastic and more or less flexible structure.

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The form of the perichondroïdal cartilages is sometimes altered by the action of mechanical agents; thus tumours of the neck, such as goitre, &c., give the tracheal and bronchial arches a flattened or triangular form by the compression which they exert upon them.

The solutions of continuity of these cartilages are not followed by their cicatrization; but the perichondrium forms a cartilaginous or osseous ring, which surrounds the fragments and maintains them in contact. This ring is smaller in proportion as the corresponding extremities of the fragments are maintained in apposition. If ossification of the cartilage has already taken place, it forms a true callus between the fractured extremities. (V. Path. Anat. of the Oss. Syst.)—Inflammation of these cartilages ordinarily terminates in ossification.

The cases of caries and necrosis that occur in the cartilaginous organs, particularly in the larynx, affect only those parts which are subject to osseous transformations.

Amongst the small number of congenital anomalies that have hitherto been observed in these cartilages, we may notice the absence of some of them, and particularly those of the ribs.

Bibliography of the Cartilaginous System.

Besides the works already cited:

Hérissant. Sur la structure des cartilages des côtes de l'homme et du cheval; dans Mém. de Paris, 1748, page 355.

Delassone. Sur l'organization des os; dans Mém. de Paris, 1752, page 253—258.—In this memoir are contained some very interesting details on the texture of the articular cartilages.

J. G. Haase. De fabrica cartiligium, Leipsig, 1767.

Doerner. De gravioribus quibusdam cartiliginum mutationibus, Tubing. 1798.

Cruveilhier. Observations sur les cartilages diarthrodiaux et les maladies des articulations diarthrodiales; dans *Arch. génér. de. Méd.*, févr. 1814, pag. 161.

Gendrin. Hist. anatom. des inflammations, tom. I, pag. 322 et seq.

CHAPTER VI.

OF THE OSSEOUS SYSTEM.

SECTION 1.

OF THE BONES.

ARTICLE 1.

General Observations.

Definition.—The osseous system is composed of an assemblage of hard organic pieces, which are united together in various ways and in such a manner as to form a kind of frame, which serves as the basis upon which the whole fabric is built; determines the general configuration of the body, the motions of its several members, and regulates its attitudes.

Situation.—The bones are always situated in the centre of the soft parts, under the teguments and the muscles that cover them.

Division.—Accordingly as one or two of their dimensions predominate, or as all three are nearly equal, the bones are divided into *long*, *broad* and *short*: when they have the dimensions of any two of the preceding kinds, they are called *mixed.* These varieties differ not only with regard to their dimensions, but also in some other characters, as we shall see when speaking of each in particular.

Conformation.—As the osseous system presents in its whole the general configuration of the body, it is evident that that of the individual bones themselves presents many

varieties in the different regions in which they are situated—a fact which indicates the division which we have just established: we shall revert to this subject in the history of the different kinds of bone; while we speak here of the protuberances and depressions which are presented on the surfaces of all the bones, and which modify their conformation.

1. *Of the eminences.*—The eminences are either articular or non-articular: the first are incrusted with cartilage, and enter into the formation of the joints; the second are destitute of cartilage, are more or less rough, and are destined for the most part to give insertion to muscles, &c. The varieties of form, which are presented by these eminences, have induced anatomists to distinguish them into several species, known under the generic names of *apophyses*, *processes*, and *rami*, when they are long and very salient; by those of *protuberances* and *tuberosities*, when they are short, rough and unequal; by those of *crests*, when they are very salient, narrow, and extended; of *spines*, when they are small, thin and acute; of *lines*, when they are long and slightly projecting.

2. *Of the depressions.*—The depressions, or cavities, are also distinguished into articular and non-articular: the first only, like the corresponding eminences, are incrusted with cartilage. (See History of the Articul.) The second, which will alone occupy our attention on the present occasion, are either external or internal. The external cavities are generally mere depressions, but sometimes they constitute true cavities: both present many varieties of form; thus, when the depressions have a large and wide cavity, they are termed *fossæ*, or digital *impressions*. When the cavities are deeper, narrow at their origin, and wide in the rest of their extent, they are termed *cells* or *sinuses*, according to their number and capacity, which are in an inverse ratio; the former being predominant in the cells; the latter in the sinuses: they are lined by a mu-

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cous membrane, and contain atmospheric air. The third class comprehends, under the names of *furrows, grooves,* &c., the depressions which are more or less narrow and elongated, and which generally receive blood-vessels and nerves; in the fourth class are included the *foramina, fissures* and *canals,* which pierce through the substance of the bones, and are more especially destined to give passage to vessels and nerves.

The osseous eminences and cavities are formed either by a single bone, or, as is most frequently the case, by the union of two or more of these organs. Many of the bones, also, present rough, uneven surfaces, which serve for the attachment of muscles, ligaments, &c.

Besides the cavities which communicate on the exterior of the bones, there are some which are completely internal, and which modify in a considerable degree, the interior conformation of these organs. On the internal surface there are small cavities which are single, and in the form of canals in the bodies of the long bones, and under the form of cells, varying in number, size and figure, in all the other parts of the osseous system. These cavities, which result immediately from the texture of these organs, are always more developed in the centre of the bones than at their extremities: they sustain the marrow and prevent one part of it from compressing another.

Texture.—The bones are composed of a fibro-lamellated tissue, very compact at their exterior, more spongy at their interior; this difference of texture has induced anatomists to distinguish in them a *compact,* a *reticular,* and *spongy tissue.* In the first, which serves always as a covering to the others, the fibres and lamellæ are applied upon each other in such a manner as to give the bone a fibrous appearance. The fibres being very irregular, and in juxta-position, leave mere microscopic interstices between them of the form of small canals, being composed of lamellated layers, united together by transverse or ob-

lique fibrillæ. The reticular tissue is less compact and constitutes the most internal layers of the bone. In the spongy tissue, the fibres and lamellæ leave small spaces or cells between them, which resemble those of sponge or of inflated cellular tissue, and form the second kind of the small osseous cavities to which we have just alluded. Modern researches have ascertained that the osseous texture is nothing but cellular tissue, hardened by its combination with a gelatino-calcareous substance, but which preserves the interior form of its primitive state until the fat is deposited into its cells.

Besides the osseous tissue, there are other parts that enter into the composition of bones, and these are: 1st, a fibrous membrane which serves as an external envelope, and which has already been described under the name of *periosteum* (v. page 94); 2d, the marrow, or the adipose tissue of the bones, which is lodged in the cells of the spongy and reticular substance, and even in the compact tissue, as well as in the large interior canal of the long bones, where it is contained in a cellulo-vascular membrane peculiar to that canal. The fat of bones consists, if not every where, at least in the most spacious lacunæ, of small spheroids filled with an oily substance, more fluid and of a more yellowish colour than that of the general adipose tissue; 3d, blood-vessels, which have been distinguished by anatomists into three orders: the first comprehends the small arterial branches, which are derived from the vascular net-work of the periosteum, and which enter the microscopic orifices, and are distributed to the compact substance. The second order consists of the vessels which penetrate into the spongy substance by the foramina, which are observable upon the surfaces of the short and at the extremities of the long bones: in the third order are included the vessels known more particularly under the name of nutritient, which traverse, without ramifying, the hollow canals in the compact substance, and are distributed to the membrana medullaris.

The corresponding veins of the first two orders do not pass out at the orifices which receive the arteries, while the arteries of the third order are generally accompanied by veins which exactly correspond to them in number and volume. The parietes of the veins of the compact and spongy tissues are formed merely of the internal membrane of the venous system; they present a cellular arrangement, which establishes an analogy between them and those which constitute the erectile tissue of the corpora cavernosa, &c., being formed, like them, merely of the internal membrane of the venous system—a character which belongs also to the small venous ramifications of the compact substance.

As yet, no lymphatic vessels have been traced into the substance of the bones; and the nerves, which accompany the vessels of the medullary membranes of the long bones, can not be discovered in the osseous tissue itself.

Characters, physical and chemical properties.—The bones are of a white, yellowish colour, very hard, compact and resisting, possessed of a very small degree of flexibility and elasticity, and susceptible of slow extension, followed, when the cause of extension is removed, by the return of these organs to their primitive dimensions; (as in some of the osseous cavities, such as the nasal fossæ, the orbit, &c. which are sometimes temporally enlarged by the presence of tumours, and which regain their original capacity as soon as these tumours are removed). The solidity of the bones depends upon their chemical composition, which, according to the analysis of Berzelius, consists of the following ingredients:—Animal substance reducible into gelatine, 32.17; insoluble animal substance, 1.13; carbonate of lime, 11.3; phosphate of lime, 51.4; fluate of lime, 2.00; phosphate of magnesia, 1.16; soda, and phosphate of soda, 1.20. The analysis of Fourcroy and Vauquelin differs somewhat from the preceding; for, besides the ingredients already enumerated, these chemists have detected the pre-

sence of a small quantity of iron and silica. The composition of the bones varies also according to the age of the individual, the state of health or disease, and the kind of bone that is examined. The gelatinous parts of bone are extracted slowly by boiling water, and the saline part is readily decomposed by some of the acids.

Vital properties.—The bones, in their healthy state, possess but a small share of sensibility; they are destitute of contractility, and the slowness with which they are formed and repaired, sufficiently proves that they are endowed with but a small degree of vitality.

Mode of development, and differences according to age.—The bones, which are at first liquid like all the other parts of the body, become gradually gelatinous, and pass successively (at least the majority of them,) into the cartilaginous and fibro-cartilaginous states, and from these into the osseous. At the commencement of embryotic life, the osseous system is merely of the consistence of mucus, and forms an uninterrupted whole, which is soon after divided into a great number of parts. Ossification begins about a month after the time of conception, and is not fully completed before the twelfth, and in some accessory parts, not until the eighteenth year of age. Ossification does not appear to result uniformly from the change of cartilage into bone. According to Howship, some parts of the osseous system, such as the bodies of the long bones and the broad bones of the cranium, pass immediately from the mucous to the osseous state. The formation of bone is accompanied by some very remarkable and curious phenomena: in the centre of the temporary cartilage, which is formed about two months after conception, and which has already the configuration of the bone, may be observed small canals, and vessels which are lined by a vascular membrane, filled at first with a viscous, and subsequently with a sanguineous fluid: the appearance of this fluid is

soon followed by that of the first osseous point.* The cartilage, being injected with red around the transformed part, presents a homogeneous aspect in proportion as it is examined near its circumference. Ossification thus extends gradually from within outwards, and finally terminates by the complete removal of the cartilage. The canals to which we have just alluded, being large at the commencement of ossification, diminish progressively, and in proportion as the process of ossification is completed: and instead of the homogeneous substance of the temporary cartilage, there is a complete bone, having distinct fibres and blood-vessels.

Though numerous hypotheses have been advanced in explanation of the conversion of the cartilaginous into the osseous tissue, our information of the nature of this nutritive phenomenon is still involved in doubt and uncertainty like that of every other part of the animal economy; and all the knowledge we possess upon this subject is, that the formation of bone results from a change of nutrition of the cellular net-work, in consequence of the afflux of blood to the cartilage, and by virtue of which, the albuminous, homogeneous substance is converted into a lamellated tissue, composed of gelatino-calcareous fibres.

In many of the bones, ossification takes place in several points; thus, in some instances, the two symmetrical halves of the azygos bones are developed separately, coalesce from the opposite sides, and are confounded with each other on the mesian line, as in the frontal and inferior

* Every normal or accidental ossification is preceded by the development of a small, red, vascular apparatus, in the point of the cartilage or fibro-cartilage which is about to be changed into bone. From the moment that ossification takes place (always in the centre of this apparatus,) the formation of vessels, or at least their development and coloration, continue to increase, and in such a manner that the ossified part is always separated from the surrounding parts by another portion injected with red.

maxillary bones; while, in some of the other symmetrical bones, as in the sphenoid, the vertebræ, &c., ossification commences by lateral and mesian points. The symmetrical bones differ from each other, both with regard to their number, and the respective arrangement of their primitive osseous points. The trace of union of some parts of the same bone, originally distinct, sometimes remains during the whole period of life, as in the bones of the sacrum. Many of the articular and non-articular eminences are formed by distinct points of ossification, which appear at very different periods, from the fifteenth day after birth to the fifteenth and sixteenth year of age. These osseous points are termed *epiphyses*, and are separated from the bone, by cartilage: when this cartilage is converted into bone, the epiphyses are changed into *apophyses*. We shall endeavour to express, in a general manner, the order in which ossification takes place in the different bones of the skeleton, though these rules do not always obtain. The two following are those which present the least exceptions; 1st, in the human subject, the bones are developed by degrees, and run through the same stages of organization as may be observed in the animal scale; 2d, The long bones are formed before the flat, and these before the short.*

* The following being the order in which the different parts of the skeleton ossify, we shall perceive how difficult it is, after having read these details, to establish general rules with regard to this point.

Ossification begins at the end of the first month in the clavicle, and successively in the inferior maxilla, femur, tibia, humerus, inferior maxilla, and in the bones of the fore-arm, where it commences about the thirty-fifth day. Ossification begins about the fortieth day in the fibula, scapula, palate, and subsequently in the central portions of the occipital and frontal bones, the arches of the first vertebræ, the ribs, the great wing of the sphenoid bone, the zygomatic apophysis, the phalanges of the fingers, the bodies of the middle vertebræ, the nasal and zygomatic bones, the ilium, metacarpal bones; the phalanges of the toes, the occipital condyles, and then in its basilar portion, the squamous part of the temporal; the pa-

The formation of bone then takes place, as we have already said, from within outwards, by the deposition of new osseous substance around the primitive nucleus: besides, the periosteum being more vascular at the period of ossification than at any other time, secretes and deposits upon its internal surface, osseous layers, which are united to the bone and add to its thickness.* It is then by a kind of juxta-

rietal and the vomer: in all these bones ossification commences about the middle of the seventh week. In the course of the same week, it begins in the orbitar process of the sphenoid, and finally, in the metatarsal bones and phalanges of the toes, and in the last joints of the fingers. During the ten succeeding days, ossification commences in the body of the sphenoid, in those of the first sacral vertebræ, and in the circle of the tympanum. About two months and a half after conception, it is manifested in the costiform appendix of the seventh vertebra; before the end of the third month, in the labyrinth, and about the end of the third month, in the ischium, and internal pterygoid apophysis; about the middle of the fourth month, in the small bones of the tympanum; at half the term of uterine life in the pubis, os calcis, the last joints of the toes, in the lateral portions of the ethmoid, and in the spongy bones of the nose; and somewhat later in the first pieces of the sternum; about the sixth month, the body and processus dentatus of the second cervical vertebra, and the anterior and internal masses of the pelvic or sacral vertebra, and subsequently, the astragalus begin to ossify. About the seventh month, the ethmoidal pyramids ossify; then the crista galli; and at the period of birth, the first coccygeal vertebra, the os cuboides and the anterior arch of the altas. About the twelfth month, the coracoid process, os magnum and unciforme of the carpus are solid; about the third year, the first cuneiform bone, the patella and the triquetral bones are ossified; at the fourth year, the second and third cuneiform; about the fifth, the scaphoid of the tarsus, the trapezium and lunare; at eight, the scaphoid of the carpus ossifies; at nine, the trapezoides, and finally the pisiforme, about the twelfth year of age. Bèclard, Anat. Generale, p. 496.

* The depressions and cavities of the bones are determined at the moment of ossification, either by the presence of some organ upon which the bone is modelled, or by active pressure, which is opposed to the development of the parts, where ossification takes place; there being no

position that the first development of the bones is effected; but, when once formed, they increase by an interstitial nutrition, which becomes gradually less active, until at a certain age, (about the time when all the epiphyses are completely ossified and are united to their respective bones,) it is no more than sufficient to nourish the bone and keep up its preservation.* In the adult, the nutritive process continues to become more slow; the number and volume of the vessels diminish, and the bones, being less pervaded with blood, become more dry and calcareous, lose their elasticity, and diminish in thickness; hence the remarkable enlargement of their interior cavities and their brittleness in old age. In the female, the bones retain a much longer

hollows in the osseous tissue as we might be led at first sight to suppose; the bones of the cranium are moulded upon the brain, the articular surfaces upon the eminences which receive them, &c. &c.

* The knowledge of the property of madder in colouring the bones of animals that have been fed with it for a long time, has led several learned physiologists to experiment with this plant, with the view to determine the *mode* of nutrition and growth of the bones. As those of Du Hamel are the most interesting, we shall sum up his principal results. The bones of young animals that have been fed with madder, soon become red, while those of old animals, on the contrary, scarcely undergo any sensible change, even after protracted feeding. If a young animal be fed with madder for some time, and then on ordinary food, the bones become red and white in alternate layers, which indicates a juxta-position, and not an interstitial nutrition. This does, probably, not take place after the epiphyses are fully united to the bones. Du Hamel does not, however, admit this juxta-position, but is of opinion, that the bones increase in length and breadth, merely by extension. To refute this theory, J. Hunter performed the following experiment: having perforated the two extremities of the body of one of the long bones of a young animal, it was killed some time after, and upon examination it was found that the distance which separated the two foramina, was the same as at the time of the operation. From the results, therefore, of this experiment, which was several times repeated, Mr. Hunter concluded that the bones are not subject to elongation.

time than in man, the characters which they possessed in youth.

Functions.—The bones form an essential part of the organs of locomotion, performing the office of levers for the action of the muscles and their tendons, which arise and are inserted into them; they also protect from external injury the brain, heart, lungs, and other organs on which life more immediately depends; as well as the larger and more important blood-vessels and nerves.

ARTICLE 2.

Of the long, broad, short, and mixed bones in particular.

§ 1. *Of the long Bones.*

Definition.—By the long bones we understand those elongated, osseous pieces, which contain a medullary canal.* They comprehend the humerus, the ulna, and radius; the femur, the tibia and peroneus; the metacarpal and metatarsal bones, and the phalanges of the fingers and the toes.

Situation.—All the long bones are situated in the extremities, which they occupy throughout their whole extent, with the exception of the carpus and the tarsus.

Conformation and arrangement.—Thick and voluminous at their extremities, where we observe apophyses of insertion, eminences and articular cavities, the bones gradually diminish and form imperfect cylinders: this intermediate part to the extremities is termed their *body* or *diaphysis.* On the body of the bone are ridges for the attachment of muscles, generally three in number, directed obliquely, and in such a manner as to give the bone a twisted

* It is from this character alone that we ought to draw the generic name of the bones of which we are treating; the other denomination being too general and equally applicable to the bones without a medullary canal, as for instance, those of the ribs.

appearance. The long bones of each extremity, taken as a whole, represent a broken column, whose pieces, being articulated in various ways, as we shall hereafter see, diminish in volume, and increase in number in proportion as they recede from the trunk.

Structure.—There is a great difference with regard to their interior form, between the body and the extremities of the long bones. The first is composed of compact substance, which is somewhat rarefied, and becomes reticular towards the centre of the bone; hence there is a canal which is lined by a cellulo-vascular membrane, which sends numerous prolongations into its interior, supported in some instances by others that are derived from the osseous substance, and forming, by their mutual interlacement, a great number of cells, which are destined to receive the adipose vesicles which are deposited in their interior, or the marrow properly so called.* The medullary membrane appears to result from a net-work of the blood-vessels, lymphatics and nerves, which are derived from the ramifications of those which enter the canal through the nutritient foramina; and are strengthened and defended from injury by cellular tissue. This membrane is commonly considered as the internal periosteum of the long bones: the quantity and consistence of the fat which it contains are in relative proportion to the exterior state of the individual: it is small in quantity, and almost entirely aqueous in emaciated persons, while in those who enjoy an ordinary degree of *embonpoint*, its proportion is more considerable. Towards the extremities of the bone, the compact substance greatly diminishes, and is finally reduced to a mere plate which covers the spongy substance of which the extremities are composed. The medullary canal is not continued into the extremities; and, although there is some-

* In birds, the medullary canal is filled with air which comes directly from the lungs.

times a small quantity of marrow in the cells of the spongy substance, there is never any distinct membrane.

Characters and physical properties.—The long bones unite to the physical characters, which they possess in common with the rest of the osseous system, the property of resisting, in a very great degree, such forces as have a tendency to break them, by virtue of the compact texture of their bodies, and of the medullary canal which occupies their centre: indeed, in consequence of this arrangement, the bones have a greater diameter, without increase of substance, and consequently of weight.

Vital properties.—The osseous part of the long bones affords nothing peculiar with regard to its vitality; but the medullary membrane which lines their interior canal is endowed with true sensibility: for when this membrane is irritated after the bone has been divided, the animal immediately evinces symptoms of pain. It is also endowed with a small share of contractility, analogous to that of the cellular tissue.

Mode of development and differences according to age.—The long bones are developed by three points of ossification; one for the body and two for the extremities. The former appears before the other two, about two months after conception, without passing to the cartilaginous state; there being already a hollow which is occupied by the principal nutritient artery. The temporary cartilages having already the form of the extremities of the bone, are united to the ends of this cylinder, and at the period of birth, ossification begins in the centre of these terminal parts; from this mode of ossification result the epiphyses which, as we have already seen, remain several years separated from the body of the bone by means of cartilage. The bones gradually increase in length by the addition of new osseous substance to the extremities of the diaphysis, and by the union of this with the epiphyses. The medullary canal, which is at first nothing but a mere narrow ca-

nal filled by the nutritient artery, gradually enlarges, and becomes filled with a soft viscid substance; as the canal increases in size, the cellulo-vascular membrane becomes apparent, which, in the fœtus and new-born infant, contains nothing but a very aqueous fluid, which by degrees acquires the properties of marrow.

The medullary canal continues to enlarge with the age of the individual, without encroaching upon the parietes of the bones, which themselves increase on their external surface; but in proportion as these cease to grow, their parietes become progressively thinner; so that in old age they form but a small share of the diameter of the body of the bone. In proportion also as the medullary canal enlarges, the quantity of marrow increases.

Functions.—The long bones constitute essential parts in the articulations of the extremities, and form solid, though flexible columns, capable of being moved in various directions, by the muscles and tendons which are attached to them.

§ 2. *Of the broad or flat Bones.*

Definition.—The class of bones which we are about to describe comprehends those pieces which vary in thickness, but are nearly equal in their length and breadth; as the frontal and parietal bones, the scapula and os ilium.

Situation.—The broad bones form, in part, the parietes of the cranium, the thorax and pelvis.

Conformation.—They are lamelliform, quadrilateral, semicircular, &c., more or less curved, or contorted in various directions, so that the same side may be entirely convex or concave, or alternately the one and the other; while the opposite sides are concave and convex. The flat bones are thicker at their circumference than in the centre, having inequalities of different kinds, which are more prominent upon their articular borders than upon those which give attachment to muscles.

Structure.—The flat bones are uniformly composed of two laminæ or *tables* of solid and compact substance: in the flat bones of the cranium the internal layer is thinner and more dense than the external, and is hence called *tabula vitrea.* In some instances these tables are in contact with each other, especially in the centre of the bone, and in others they are separated by a layer of intermediate spongy substance called the *diploë.* This is exceedingly vascular, having a great number of veins, and containing a small quantity of marrow without any distinct membrane.

Mode of development, and differences according to age.—The broad bones are developed by two or more points of ossification, which become manifest in the mucous substance at the end of the second month of pregnancy, between the periosteum and the dura mater for the bones of the cranium, and between the two laminæ of the periosteum for the other flat bones. The osseous fibres issue in rays from the centre towards the circumference, and finally form laminæ with radiated fibres, which are still separated by the mucous substance. It has been observed by Bichat, that we ought to refer the origin of the sutures, which unite some of the flat bones with each other, to the interspaces which are left at this period between the fibres of these bones. Soon after the laminæ of which the flat bones are composed, are united, their substance becomes more conspicuous, and the tables, which were at first confounded, become more distinct in proportion as they increase in density; leaving between them, as they separate, an intermediate spongy substance formed at the expense of the internal fibres of their contiguous surfaces. In old age this substance is absorbed, the two tables are again brought in contact, and the bone becomes sensibly thinner and weaker: to this circumstance ought to be attributed the sinking of the parietal protuberances observable on the skulls of old people.

Functions.—The flat bones serve to defend from exter-

nal injury the organs which are contained in the cavities which they contribute to form, and participate in the functions of locomotion, either by furnishing immoveable fulcra for the action of the muscles, or in performing the motions which these organs impress upon them.

§ 3. *Of the Short Bones.*

Definition.—Under this class are comprehended all the bones whose length, and breadth, and thickness, are nearly of the same dimensions.

Situation.—The short bones are generally collected in groups, and are situated in the hand and foot, &c., and in the vertebral column, which is formed exclusively by them.

Conformation.—The short bones present too many irregularities to enable us to point them out in a general description. Their form is generally determined by the parts around and between which they are situated: they are globular, tretroidal, cuneiform, cuboidal, &c.: all of them are furnished with eminences and depressions, either for their articulation or for the attachment of the soft parts.

Structure.—The internal substance of the short bones consists of a soft, spongy, and areolar texture, which is covered and defended exteriorly by a layer of firm compact substance: they are supplied with blood-vessels, and contain a small quantity of marrow without any distinct membrane, like all the bones that have no medullary canal.

Mode of development, and differences according to age.—The short bones ossify slowly, and pass from the mucous to the cartilaginous state; and the temporary cartilages in which they are formed have the shape and volume of the bone long before it is completed: ossification of the short bones also takes place from the centre towards the circumference, and is attended with the same phenomena as the ossification of the other bones. Some of the short bones are developed in the thickness or in the continuity of some of the tendons or ligaments, and pass successively

from the fibrous to the fibro-cartilaginous state, and finally to the osseous. The patella and the sesamoid bones are formed in this way; so that they do not appear to be essential parts of the skeleton, and are considered by some as accidental bones.

Functions.—Nature has placed the short bones in every place, where it is necessary to combine a great degree of solidity with that of mobility. To attain this double purpose, it was necessary that they should be small and arranged in groups. Indeed, we know, that an instrument, formed of several pieces which are firmly united together, is more solid than one that is composed of a single piece, because such efforts as have a tendency to break it are lost at their point of union, and that the principal motion of a series of organs occupying a given extent, is also much greater in proportion as these organs are more numerous, and consequently smaller. The short bones of the vertebral column, moreover, form a kind of bony case for the spinal marrow, which is thus defended from external injury.

§ 4. *Of the Mixed Bones.*

Definition.—The mixed bones are those which combine the form and characters of the preceding classes, and appear to result from the union of the bones of two or even three of them; as in the sphenoid, the ethmoid, the temporal, the occipital, the ribs and the sternum.

Situation.—Most of them belong to the head and the thorax.

Conformation.—Their form is very variable, and results most frequently from the union of a broad, a short, and a thick part.

Structure.—The mixed bones present the same structure as the bones with which they are connected. It is in this class that is comprehended the hardest and most com-

pact osseous part of the skeleton, viz. the petrous portion of the temporal bone.

Mode of development.—These bones are formed by several points of ossification, and possess in each of their respective parts the mode of development of the kind of bone with which they are connected.

Functions.—The mixed bones perform different functions in the animal economy; they contribute to form the cranium and the thoracic cavity, surround and defend the organs which they contain, the encephalic nerves and some parts of the organs of sense, and give attachment to muscles.

Pathological Anatomy.

The bones are often subject to mal-formations, which are either congenital or accidental. The first are frequently observed on the vault of the cranium, less often on the parietes of the thorax and abdomen, and seldom in the extremities. They consist either in a defect, or in an excess of development of the osseous parts where they are found, and are most frequently accompanied by congenital anomalies of the viscera which they surround. The mal-formations which are consequent upon the development of the bones, depend sometimes upon accidental hypertrophy or atrophy, as may be observed in some of the chronic diseases. Sometimes also they result from inflammation and swelling of the periosteum, accompanied by the secretion of osseous matter, which is deposited upon the internal surface of that membrane, and which, uniting with the bone, constitutes what is called *external exostosis:* this morbid development is presented either under the form of a circumscribed nodosity, and is then termed *node,* or under that of a tumour, varying in extent, and composed of large and superadded layers. When treating of inflammation of the bones, we shall have occassion to point out some of the

various alterations which it is capable of producing in the osseous system.

The solutions of continuity or fractures of the bones, deserve our particular attention in relation to their mode of *healing*. In the following exposition of the different theories of the formation of callus (cicatrix,) that have been hitherto advanced, we shall see the great discrepancy in the opinions of some of the most learned and experienced physiologists, with regard to this highly interesting and important subject.

The ancients were of opinion, that the extremities of the fragments of a broken bone secreted a kind of osseous fluid or coagulable lymph, which gradually acquired consistency, and glued the extremities together. Haller afterwards extended this theory, and asserted that the fluid, exhaled by the extremities of the fragments and the marrow, was effused around them, and became successively mucous, then cartilaginous, and finally osseous; passing thus through all the different stages of the original ossification. According to Haller the periosteum is entirely passive in the formation of callus. By Mr. John Hunter the formation of callus is referred to the organization and ossification of the blood which is extravasated around the broken fragments. In the present day, Mr. Howship, embracing the ideas of M. Dupuytren, has added additional proof to the theory of Hunter, and asserts that the periosteum becomes cartilaginous at the extremities of the fragments; that the matter of callus is deposited successively upon the surface of the bone, the circumference of the extremity, and in the medullary cavity; —in a word, that the fragments are firmly re-united at their exterior parts before they are cicatrized at their extremities. The theory of Du Hamel, published before the time of Haller's, tends to prove, that the periosteum and the medullary membrane, and sometimes the first only, are elongated and united to those of the opposite frag-

ments, and ossified in such a manner as to surround the fracture by a kind of osseous ring. This re-union, in which, according to Du Hamel, the extremities of the fractured bone themselves did not participate, was regarded by him as definite. According to the opinions of Bordenave, Bichat and Richerand, fractures, that are attended by laceration of the soft parts, have their contiguous extremities re-united by the development of fleshy granulations. Notwithstanding the theories already stated, little was known with regard to the phenomena of osseous cicatrization, until the researches of Dupuytren, Breschet and Villermé, threw new light upon this subject, and gave us more correct and satisfactory information. We shall find in the ideas of these gentlemen some of those of Du Hamel, of Haller, and of Howship. According to the new theory, there are three distinct stages for the formation of callus. In the first stage, the small quantity of blood, that escapes and is effused between the fragments at the moment the fracture occurs, is soon followed by the exhalation of a viscid serum; the blood gradually loses its colour, and the periosteum, the medullary membrane, and the divided soft parts are re-united. The second stage is characterized by inflammation and swelling, accompanied by the secretion of coagulating lymph in the thickness of the periosteum, and between it and the bone: this matter is gradually ossified, as well as the medullary membrane: externally, the ossification extends to the surrounding cellular tissue, and even to the muscles. Finally, a *provisional callus* is formed, a kind of osseous incrustation on the surface of the contiguous extremities, which may be compared to the osseous rings (virole,) observable in a great number of bones, and which, in the long ones, is completed by the formation of a kind of osseous *pin* (cheville) in the medullary cavity, in consequence of the ossification of the medullary membrane. The provisional callus is nothing more than a kind of solid, *retentive apparatus*, which serves to maintain the fragments in contact. As soon as

this is formed, commences the third stage—that of the permanent callus. Until now the bone itself has experienced no sensible changes; but at this period the substance that was effused between the fragments acquires consistency and firmness; vessels are developed which communicate with those of the bone and the periosteum, and finally ossification is effected, and the two extremities are thus firmly re-united. When this consolidation is perfect, the provisional retentive apparatus is gradually absorbed, and the medullary canal is re-established. When the fragments, however, can not be maintained in their natural relations, after they have been brought in contact, the medullary canal remains obliterated, and the exterior callus, instead of being merely provisional, becomes permanent. When the fragments are not properly reduced, and maintained perfectly in contact, they are re-united by a kind of fibrous cicatrix, which generally happens in fractures of the patella and cervix femoris, on account of the difficulty of preventing the separation of the fragments.

Sometimes the extremities of the fragments are rounded, becoming firm and compact, and even incrusted with cartilage, and covered by synovial membrane: hence the anomalous articulations which either prevent or greatly impede the motions of the injured parts.

It sometimes happens that the epiphyses are separated from the bones by mechanical causes, or morbid changes, such as inflammation; and in these cases re-union is effected in the same manner as in fractures. In cases of comminuted fractures, the disorganized parts are re-united by callus. Wounds of the bones, with loss of substance, are generally followed by mortification, and exfoliation of the external laminæ, and subsequently, by fleshy granulations and the restoration of the exfoliated substance.* In gene-

* When the periosteum alone has been injured, and the soft parts are immediately brought in contact, re-union often takes place without previous exfoliation.

ral, wounds of the bones are rapidly repaired, and show the great recuperative power of the osseous tissue. The bones are often rendered thin by the pulsations of aneurismal tumours, and are even sometimes perforated, especially when they are thin and soft and in contact with the tumour.

After amputations, the extremity of the osseous fragment of the stump inflames, unites with the surrounding soft parts, and is rounded and covered with a compact osseous plate, which closes up the mouth of the medullary canal. If there be lesion of the bone or the periosteum, beyond the extremity of the fragment, slight exfoliation takes place, but the cure is afterwards effected as in ordinary cases.

Primary inflammation of the bones is a very rare disease; but it is often propagated to them by the surrounding parts, and always in consequence of mechanical injuries; and under these circumstances it is that we can best observe in them the anatomical characters of this morbid state. When the osseous tissue inflames, it swells, becomes more spongy and rarified than in its normal state, and its vessels are highly injected with blood. These phenomena are accompanied by the secretion of a gelatinous or red serous fluid, which is deposited into its cells; the calcareous salts are gradually absorbed, and the gelatinous substance itself is evidently altered; the medullary canal disappears in the neighbourhood of the affected part; and the membrana medullaris, whose interior elongations are red and thickened, is filled in its interstices with a fibrous substance. Inflammation of the bones often terminates in mortification or *necrosis:* their compact portions are more especially subject to these morbid derangements, on account of their small degree of vascularity. The necrosed part is uneven and of a reddish brown colour; and sometimes, when mortification succeeds to gangrenous inflammation, the eschar is brown and spongy, and emits the smell that characterizes gangrene of the soft parts: most frequently the gelatinous substance of the bones disappears, and even

sometimes, the calcareous salts themselves are decomposed. The hospital gangrene also extends to the osseous tissue, and reduces it to a soft, grayish, fœtid, and pultacious substance.

In necrosis of the long bones there are some interesting peculiarities, which are important to be understood by the surgeon, and which afford another example of the recuparative powers of the tissue of which we have been treating. When the body of one of the long bones is mortified, either in part or in whole, nature sets up her restorative efforts, and forms around it another osseous portion equal to the original, and pierced by several apertures, by traversing which by means of a stylet, we may perceive the dead bone, and readily distinguish it in the interior of the new, by its mobility.* The *sequestrum* or dead part is discharged, either by the efforts of nature, or those of surgery, through the apertures to which we have just alluded: after the removal of the sequestrum, the openings gradually close; and the new bone, assuming the form of the original, unites with its terminal portions, and, finally exceeds it in density:—it is furnished with a medullary canal and membrané. In cases where the entire thickness of the body of the bone is necrosed, the restoration is effected by the periosteum: in some instances, the internal laminæ alone are mortified, and then the reproduction consists merely in an increase of the external plates, accompanied, as in all other cases of new formation, by the phenomena which are necessary for the removal of the sequestrum: in necrosis of the flat and short bones, and in the extremities of the long ones, restoration is less frequently effected than in the bodies of the long bones.

Caries, or softening and ulceration of the bones, is another

* The probe penetrates as far as the sequestrum by traversing the fistulous openings, which nature has established in the soft parts, to favour its elimination.

effect of inflammation: it is characterized by a softening of the osseous tissue, accompanied by a great degree of friability, and a fetid ichorous discharge; when the quantity of this fluid is small and inconsiderable, the disease is termed *dry caries*—a variety which seldom occurs but in the flat bones and in old people. This ulcerative inflammation attacks more particularly the spongy bones, so that the short bones are more liable to be affected by it, than the others.

When the inflammation has continued for some time, the oseous tissue becomes swollen and assumes a lamellated appearance; its fibres separate, and contain in their interstices a thick reddish matter, of the intermediate consistence of indurated cellular tissue and tubercles: this matter is often converted into fibro-cartilage, and finally into an osseous substance constituting a kind of exostosis, characterized by a simultaneous swelling and increase in the density of the bone. In the exostoses, which are derived from the bone itself, there are all the characters, that are presented in the sub-inflamed osseous tissue—facts which amply prove that these tumours are the result of phlegmasiæ. It is indeed, to inflammation that we ought to look for the cause of *spina-ventosa*, and of osteo-steatoma, in which the swelling of the organ is combined with the condensation of its tissue and the alteration of its chemical composition. The bones often experience tuberculous, schirrous and cerebriform *degenerations*, &c.: they are also subject to a remarkable softening, which arises from an absorption of the earthy part of the osseous system, while the animal matter remains. When this disease arises during the growth of the individual, it constitutes what is termed *rickets*. The bones of ricketty subjects are of a reddish appearance, spongy, and easily cut with the bistoury; and those which are naturally spongy, become more rarefied and voluminous than the others; as in the extremities of the long bones, whose size induces the vulgar to say that the subject is

ricketty. This state is generally only temporary; but as they acquire their natural density and solidity, the bones retain the deviations and curvatures which the pressure of the body and the action of the muscles produced during the disease. The *mollities ossium* is a disease arising from a softening of the bones, and is generally attended by a greater degree of absorption of the earthy salts, than in the disease called rickets: it often supervenes after the formation and growth of the bones are complete; when it is accompanied by a softening and fleshy appearance of the osseous tissue, it is called osteo-sarcoma. In some instances, the bones are soft and brittle, at the same time that they retain their cellular texture.

All the tissues, whether normal or adventitious, are subject to accidental osseous productions: in the first, they result ordinarily from the effects of old age, and are seldom perfectly similar to the osseous tissue. Sometimes, these productions consist in mere incrustations, having a greater quantity of calcareous matter than bone, as in the arteries; at others, they consist of a soft, friable, chalk-like substance, composed of animal matter, and earthy salts, as well as a kind of ebony-like substance, as is sometimes found to occur in the cartilages of the diarthrodial joints. Ossification of the cartilages and fibro-cartilages presents all the characters of the osseous tissue.

SECTION 2.

Of the Articulations of the Bones.

The bones are connected together through the medium of other substances, and in such a manner as to form an entire whole called the skeleton, which determines the general configuration of the body, and constitutes the basis upon which the whole fabric is built. The bones are all so admirably arranged, that the extremity of every one is

perfectly adapted to the end of the bone with which it is connected; and this connexion is termed their *articulation.* Every articulation has its articular osseous parts and the media by which they are united. The articular surfaces, generally, present inequalities, which determine the different kinds of joints, as well as the extent of motion of the moveable articulations. The long bones are articulated by their extremities, the broad ones by their borders, and the short ones by different points of their surfaces. All the bones are united through the media of cartilages, fibro-cartilages, or, fibrous ligaments. In consequence of the variety of form of the articular parts; of the differences of their mode of union, and their immobility or mobility, anatomists distinguish three kinds of articulation; the first is called *synarthrosis,* the second *amphiarthrosis,* and the third *diarthrosis.*

1. *Synarthrodial Articulation.*—All the bones of the head, except the inferior maxilla, are connected by the synarthrodial articulation, and are immoveable with regard to each other. The articulatory parts present many varieties as regards their form and relations, but they are all united by an intermediate cartilage which adheres firmly to them, and by the periosteum which covers it in its passage from one bone to the other.

In old age, the synarthrodial articulation is often obliterated by the immediate continuity of the two bones which it connects, in consequence of the ossification of the synarthrodial cartilage. Synarthrosis is divided into several varieties:

1st. The *true suture* is that kind of articulation which exists between the bones of the cranium, where the articular surfaces present a great number of indentations, which correspond to an equal number of proportionate depressions, into which they are received. Owing to the trifling differences which exist in the form of the indentations, this

suture has been divided into three varieties, viz., the *dentata*, *serrata*, and *limbosa.*

2d. *The false or harmonic suture*, in which the bones are connected together by means of rough margins; in this manner the bones of the nose are connected together.

3d. The *scaly suture*, when the corresponding bones overlap each other, by the separation of their borders, which are sharp and unequal, as in the temporo-parietal articulation. The scaly suture is said to be double or reciprocal when the bones do not correspond by the same surfaces throughout their whole extent: the spheno-frontal articulation is an example of this variety.

4th. *Schindylesis*, when a thin lamella of bone is received into the narrow furrow of another, as in the articulation of the vomer with the ethmoid and sphenoid.

5th. *Gomphosis.*—This term is expressive of the mode of articulation of the teeth with the alveolar cavities, if the first be considered as bones.

2. *Amphiarthrosis.*—Amphiarthrosis is nothing but a mixed or synarthrodial articulation, with large, smooth, articular surfaces connected together by an intermediate fibro-cartilaginous substance, which adheres firmly to them, and has sufficient suppleness and elasticity to admit of an obscure motion. Thus the bodies of the vertebræ are united, and move upon each other by turning upon their axes, or in bending forwards. The fibrous ligaments which are situated around the amphiarthrodial articulations also add to their solidity; though, they are subject at the different periods of life to the changes dependant upon those that are experienced by the intervertebral fibro-cartilages. (See Fibro-Cart. Syst.)

3. *Diarthrosis.*—Diarthrosis or moveable articulation, results from the contiguity of osseous surfaces which are incrusted with cartilage and lined by synovial membrane. This kind of connection takes place between the bones of the extremities and the trunk; between the os occipitis and the

vertebra dentata, and between the ribs and the vertebral column, &c. &c. The diarthrodial surfaces are sometimes plain, more frequently convex or concave, or both at the same time; but their configuration is always such that they adapt themselves readily to their corresponding parts. When the convex eminences stand out in a roundish ball and constitute the entire articular surface, they are termed *heads;* when they are rounded, elongated and flattened, they obtain the appellation of *condyles.* When the heads and condyles rise narrow, and then become larger, the narrow or small part is termed *cervix* or *neck,* as in those of the femur and humerus.—When the depressions are deep, are more or less concave, and constitute the entire articular surface, they are denominated *cotyloid* and *glenoid* cavities: sometimes they are designated by the names of *pulleys* or *trochlea.* The diarthrodial articulations are connected by means of fibrous ligaments, which are generally attached around their circumference, and sometimes to their centre, and always in such a manner as to admit or prevent different kinds of motion. The firmness of the diarthrodial joints is less than in the other classes of articulations, and is generally in an inverse ratio to their mobility. Diarthrosis is sub-divided into several species, which differ from each other by the form of their articular surfaces, their means of union and their quantity of motion.

1st. *Planiform Diarthrosis** is the articulation where the articular surfaces are nearly plain: are connected by strong and firm ligaments, and are susceptible of vague, but obscure motions, as in the junction of the ossa cuneiformia with the os naviculare; of the articular processes of the vertebræ, &c.

2d. *Arthrodia.*—When the articular surfaces are more round, less firmly united, and susceptible of more extensive motions than in the preceding.

* The amphiarthrosis of Meckel and some other anatomists.

3d. *Enarthrosis*, when a large head is received into a deep cavity, and is maintained there by a capsular ligament: this species of union admits of motion to all sides.

4th. *Lateral ginglymus.*—When the articular surfaces are convex in the one and concave in the other, and have a part of their circumference formed by an osseous cylinder, and the other by a ligament; as in the articulation of the radius with the ulna.

5th. *Angular ginglymus, or ginglymus, properly so called.*—In this articulation the surfaces present eminences and depressions, by means of which they move the one upon the other; and where, by the arrangement of these projections and the ligaments which connect the joint, the motions are confined to flexion and extension, as in the articulations of the elbow and the knee.

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The diarthrodial articular surfaces are often displaced in consequence of such efforts as have a tendency to extend or rupture the ligaments which connect them: these displacements are termed *luxations;* and, when they supervene in consequence of organic alterations of the ligaments, they receive the appellation of *spontaneous*. The articulations are more subject to these displacements in proportion as they are more moveable, and their articular surfaces are smaller, and less intimately connected.

Besides the *accidental* articulations which are sometimes established, as we have already seen between the two fragments of a broken bone, there are others, which are termed *supplementary*, and which are consequent upon irreducible luxations: thus, when the articular head of a bone is removed from its cavity, it is applied against another bone, and produces a depression whose circumference is strengthened by a fibro-cartilaginous or osseous border, while its bottom is lined by a substance analogous to fibro-cartilage: —in fact, we generally find these kinds of articulation pos-

sessed of fibrous and capsular ligaments, &c., and of synovial membranes. The natural cavity becomes obliterated, and assumes the form which it would have received originally from the free development of all its osseous points: it is in this manner that the cotyloid cavity, which is developed by three points of ossification, becomes triangular after the complete displacement of the head of the os femoris.

In some instances the synarthrodial articulations become swollen and relaxed: it is in this manner that the symphysis pubis is separated during the last stages of pregnancy, in consequence of the swelling and softening of the intermediate fibro-cartilage.* In some cases this separation of the articular surfaces amounts to a considerable extent, as is observed in some of those cases which result from hydrocephalus and the effects of external injury.

The bones are sometimes firmly articulated together, either in consequence of acquired stiffness and rigidity, and the ossification of the connecting ligaments; or in consequence of adhesions between the contiguous parts of the synovial membrane; or in consequence of the synovial membrane, and cartilages of the articulation having been destroyed by inflammation or some other cause, the spongy extremities of the bones are brought in contact, and are united with each other: in the last case, which constitutes what surgeons have called *true anchylosis*, the motion of the joint is completely destroyed, while, in the preceding,

* This separation of the pubes being of very rare occurrence in the human subject, should by no means be regarded as a provision of nature intended to facilitate the delivery of the female; but as purely accidental, and as a consequence of some morbid derangement of the intermediate fibro-cartilage.

In some animals, however, as the Guinea pig, this separation of the bones of the pelvis during the latter stages of pregnancy, does actually take place, and seems to be an operation of nature intended to facilitate the parturient efforts.—S. D. G.

which constitute *false anchylosis*, the motion is always less than in the natural state, and is also, sometimes, totally destroyed. The articulations of the elbow and the knee are more frequently affected with anchylosis than any other joints in the body.

The diseases known under the name of white-swelling, depend most frequently upon chronic inflammation, and affect, either alone or simultaneously, both the soft as well as the hard parts of the articulations.

Bibliography of the Osseous System.

Besides the works already quoted:

Malpighi. De ossium structura in op. posthum.

B. S. Albinus. De constructione ossium, *in* annotat. Acad., Lib. VII, cap. 17.

Delasóne. Mémoire sur l'organ. des os; dans les Mémoires de l'Acad. royale des sciences. Paris, 1751.

J. G. Courtial, J. L. Petit et Lémery. Description exacte des os, comprise en trois traités.

A. Scarpa. De Penitiori ossium structura commentarius. Lips., 1795, Paris, 1804.

V. Malacarne. Auctuarium obs. et icon. ad osteol. et osteopath. Lugduwigii et Scarpæ; Patav. 1801.

On Osteogeny consult the following:

H. Eysson. De oss. infant., cui tractatui annexus est *V. Coiter* ossium infantis historia. Groning., 1659. *Th. Kerkring.* Osteogeniæ fœtus. Lugd.-Bat., 1717. Albinus. Annot. Acad., lib. VI, VII.—*Id.* Icones oss. fœtus hum. accedit osteogeniæ brevis historia. Lugd.-Batav. 1737.—*Duhamel,* Mém. de l'Acad. royale des sciences, ann. 1739—41—43—46.—*Haller,* experimenta de oss. formatione, in op. min. II.—*Hérissant,* Mém. de l'Acad. royale des Sciences; 1768.—*Béclard,* Mém. sur l'ostéose, dans le Nouv. Journ. de méd., vol. IV, 1819.—*Serres,* Des lois de l'Ostéogénie; analyse des travaux de l'Acad. royale des Sciences, ann. 1819.—*Dutrochet,* observa-

tions sur l'Ostéogénie, dans le Journ. de physique, sept. 1822.

On the history of Callus, consult,

Duhamel. Mémoires de l'Acad. royale des Sciences; Paris, 1741.—*P. Camper*, Observat, circa callum ossium fractor.; in Essay, and obs. phys. and litter., vol. III. Edimb., 1771.—*Bonn*, de ossium Callo, etc.; Amstel. 1783.—*Macdonald.* De Necrosi et Callo; Edimb. 1799.—*Breschet*, quelques recherches historiques et expérimentales sur le cal; Paris, 1819.—*J. Sanson*, Exposé de la doctrine de M. Dupuytren sur le cal; dans le Journal univ. des Sciences médic., tome XX, p. 131.

On the pathological anatomy of the bones, consult:

Tenon. Trois mémoires sur l'exfol. des os, *in* Mém. et observ. sur l'anatomie, la pathologie et la chirurgie, etc. Paris, 1816.

J. L. Brachet. Mém. de Physiol. pathol., sur ce que devient le fragment de l'os après une amputation; *in* Bull. de la Soc. médic. d'émul. de Paris, 1822.

Chopart et *Robert.* De Necrosi ossium theses anat.-chir.; Paris, 1765.—*Troja*, de nov. oss. Paris, 1775.—*Charmeil*, de la Régénération des os. Metz. 1821.

Reichel. De Epiphysium ab ossium diaphysi diductione. Lips., 1769.

A. Bonn. Descriptio thesauri ossium morbosorum Hoviani. Amstel. 1783.—*Sandifort*, de ossibus diverso modo a solita conformatione abludentibus; in obs. anat. path., lib. III et IV. Lugd.-Batav., 1777—81.

The following works on accidental ossification may be consulted with much advantage:

J. H. Van Heckern. De Osteogeni præternaturali; Lugduni-Batav., 1797.—*P. Rayer*, Mém. sur l'ossification morbide; dans les Arch. gén. de médec., tome I; Paris, 1823.

CHAPTER VII.

OF THE NERVOUS SYSTEM.

SECTION 1.

General Observations.

Definition.—The nervous system is an assemblage of organs which are continuous with each other, are formed by one of the secondary elements of the animal organization—the nervous substance; and are composed, first, of masses or ganglia of different sizes, and secondly of fasciculi and cords; some of which establish communications between the different masses, while others extend from them to the different parts of the body.

Division.—From remote ages to the present day, anatomists have regarded the nervous system as composed: 1st, of a central unique part—the spinal marrow, according to Praxagoras and Bartholine, and the brain according to Galen and most of his successors; and 2d, of prolongations, by which they understood the nerves and all the other parts of the nervous system. Bichat, in unfolding the theories of Winslow and Reil, established the distinction of two nervous systems: the one, which he called the *nervous system of animal life*, consists of the spinal marrow, the brain and the nerves which are given off by them; the other, termed the *nervous system of organic life*, comprehends the ganglia and the nerves which form the *great sympathetic* or *trisplanchnic* nerve. With regard to the

latter, Bichat has proved that it does not consist of a single system, but of a combination of small distinct systems, communicating together, and with the great cerebro-spinal system. Thus, Mr. Gall asserts, that the encephalon and spinal marrow are an assemblage of ganglia or independent nervous systems, united by filaments of communication, and susceptible of being brought under three groups. The first comprehends the nervous apparatus of the voluntary motions and of the tactile sensations, or those which form the spinal marrow; the second consists of the nervous apparatus of sense, comprehended under the name of medulla oblongata, and the third, of the cerebrum and cerebellum, or those of the faculties of the mind. A fourth group, composed of the ganglia and the trisplanchnic nerves, completes the grand nervous apparatus.

The plurality of the nervous system is generally admitted at the present day; but many anatomists, in adopting this *capital doctrine*, have modified its application, and especially M. de Blainville, who, founding his opinion upon profound study of comparative anatomy, has defined the nervous system, considered with regard to the whole scale of animal beings, to be "a number of ganglia of different sizes, each of which sending off nerves, some to be distributed to the organ which it is to animate and endow with its appropriate life, and others to communicate with the other ganglia and the central ganglion (when it exists) to establish its general life." The central ganglion exists only in the higher classes of animals, and establishes, in the most complete manner, the individuality of being. M. de Blainville, in applying these ideas to the nervous system of man, represents it as being composed of a central part—the spinal marrow—at the extremities and upon the sides of which are placed ganglia that perform entirely different functions. At its superior extremity and on the mesian line, there are seven ganglia composing the encephalic mass, and being subservient, some to the intellectual facul-

ties; others to the senses, the partial motions of the head, and to the functions of respiration and digestion. On each side of the spinal marrow is another set of ganglia which give origin to the spinal nerves:—finally, in the splanchnic cavities are the ganglia which are subservient to the functions of nutrition, and are situated near the organs to which they distribute their nerves; these ganglia are, the cardiac ganglion in the thorax, and the semi-lunar plexus in the abdomen. The trisplanchnic holds the same character here as was assigned to it before the time of Bichat, being an intermediate nerve to all these apparatus, and destined to establish communications between them, and in a word, to be a true sympathetic nerve.

We repeat here, that the doctrine of the plurality of the nervous system is generally admitted in the present day, and that authors differ only in regard to the application of this capital idea. The manner in which M. de Blainville regards the grand apparatus of which we are treating, is undoubtedly that which is the most expressive of the general laws of organization. Although the ideas of this anatomist are not as yet generally adopted, it becomes us, in a work of this kind, to adopt the division of the nervous system into the *cerebro-spinal* and the *trisplanchnic*, a division, which will at once facilitate the description of this system, and enable us to give an account of the different opinions of the physiologists that have written upon this subject.

Situation.—The nervous system is spread throughout every region of the body: its central parts are situated interiorly, while its large cords are more superficial, and approach nearer towards the periphery in proportion as they ramify: we shall have occasion to see, however, in a subsequent part of this work, that there are some important differences with regard to the situation of the two divisions of the nervous system.

Form and general arrangement.—The nervous sys-

tem may be represented as a grand net-work, whose filaments, being interrupted by the small ganglia in the different regions of the body, and united together by frequent communications, extend from the periphery of the body to the brain and spinal marrow, diminishing in number, and acquiring, generally, a larger volume, and a more completely symmetrical arrangement in the two lateral halves of the body: this arrangement is more perfect in the brain and spinal marrow than in any other part of the nervous system.

Texture.—The nervous system is far from having the same organization in every part, notwithstanding in this respect it presents the same common characters. Every part is formed of a peculiar substance called the *nervous fibre*, which has been regarded by M. de Blainville as a secondary element, resulting from the modification of the primary or cellular element of our bodies. This nervous substance is presented under two principal aspects, which has led to the distinction into the *white* and *gray* substance. We shall presently see that this distinction does not merely rest upon the difference of colour indicated by these denominations.

1. *White substance.*—The white substance of the nervous system forms a continuous whole, and is generally surrounded by the gray substance; but this is not the case everywhere, as the term *medullary*, which is also sometimes used to designate it, would appear to indicate. If its consistence be increased by immersing it in alkohol, or in weak solutions of the nitric or muriatic acids, upon dividing it, it will exhibit a very remarkable fibrous structure, apparent in some parts, as in the nerves without previous preparation. The fibres are disposed in parallel or oblique fasciculi, which can be readily separated into capilliform fibrillæ; but the mechanical division can not be carried so far as to enable us to say whether these filaments, which are very intimately united together, are themselves

composed of other still more minute fibrillæ. The white substance is plentifully supplied with blood-vessels, but not so much so as the gray.

2. *Gray substance.*—The gray substance is generally situated externally to the white; so that it is often called *cortical*—a term which is by no means always applicable, as we shall see in the next section. It does not, like the white substance, form a continuous whole; but is always found in insulated portions. This substance occurs at the central extremities or points of origin of the nerves, and is there more abundant in proportion as the nerves are larger and more numerous, as in the superior part of the brachial plexus: it is found, also, everywhere where the white substance is most abundant and more fully developed. From this disposition, many physiologists have inferred that the gray substance produces the other, and is the matrix of all the nerves. If this were true, the appearance of the first would necessarily precede that of the second, which is not the case, as we shall presently see. The fibrous texture of the gray substance being difficult to be distinguished, even when prepared as we shall hereafter direct, is not admitted by all anatomists, though its existence does not appear to be doubted at the present day, at least not in the encephalo-rachidian mass. The gray substance is generally very vascular; but variously in the different parts of the system.

Examined with the microscope, the nervous substance appears to be composed of small, semi-transparent globules, connected together by a viscid substance, irregularly disposed according to some, (as in the brain;) and according to others, in linear orders, (as in the nerves,) so as to form extremely delicate fibres. Anatomists are not perfectly agreed as regards the volume of these globules; some assert that they differ in the different parts of the nervous system, and agree to locate the largest in the encephalon; while others, equally positive, affirm that their diameter is every-

where the same. According to the late researches of M. H. M. Edwards, their diameter is equivalent to 1-3000 part of an inch. As to the nature of the globules, the Wenzells, who have made a great number of observations, regard them as vesicles containing a white or grayish substance, according to the parts in which they are situated; but all our knowledge upon this subject is still involved in doubts and hypotheses. The globules appear to be connected together by extremely delicate cellular tissue, which also connects, and in a very intimate manner, the small delicate fibres which result from their linear disposition. The cellular tissue, which is more compact on the surface than in the interior of the nervous organs, forms a thin membranous layer, having different names, and varying in different parts, as we shall have occasion to point out in the following sections. This membrane is exceedingly vascular, and the vessels which are distributed upon it, penetrate the nervous substance, and are, as we have already said, more numerous in the gray than in the white substance. The nervous system appears to be destitute of lymphatic vessels.

Characters, physical and chemical properties.—The nervous organs are very excellent conductors of the electric fluid. The two substances do not everywhere present the same shades of their respective colours; the grayish substance, especially, varies so much, that in some places it is yellowish, ash-coloured, and even black; these differences of colour, however, depend uniformly upon the degree of vascularity of the part. The consistence of the medullary substance is by no means the same in every part of the nervous system; but it is always in relative proportion to that of the cortical: both, but especially the medullary substance, are slightly elastic, retractile, and more resisting in the direction of their fibres than in any other. When macerated, the nervous substance resists for a long time the action of water, and its first effect is a

softening and slight discoloration of the cortical substance. The effects of the dilute acids and of alkohol, upon the cortical and medullary substances, have been already pointed out. By desiccation the former is rendered brittle and pulverizable, and both are rendered hard by solutions of the bi-chloride of mercury. According to the analysis of M. Vauquelin, the nervous substance is composed of the following ingredients:—a white fat, 4 53; a reddish brown liquid fat, called cerebrin,* by M. Chevreul, 0.7; water, 80; albumen, 7.0; osmazome, 1.12; phosphorus, 1.5; phosphate of potash, muriate of soda, phosphate of lime, and phosphate of magnesia, 5.15. The quantity of albumen is in an inverse ratio to that of the fatty matter, which is most abundant in the spinal marrow, less in the brain, and quite small in the nerves: the phosphorus appears to exist only in the medullary substance. The analysis of Vauquelin has no reference to the grayish substance of the ganglia of the great sympathetic.

Order of development and differences according to age.—We have no positive knowledge with regard to the time in which the nervous system begins to be perceptible, nor of the state in which it is at its origin. It appears, however, to be one of the first of the systems that are developed. Its different parts are not formed simultaneously, but in a gradual and successive manner;† and though authors are not agreed upon the order of this succession, it would appear sufficiently evident that the nerves and their ganglia appear first; then the medulla spinalis, and finally, the different parts of the encephalon. This general order, and that which we shall point out hereafter, when speaking of each part of the central masses in particular, correspond to that in which the nervous system is pro-

* According to M. Chevreul, this substance also exists in the blood.

† This progress of the development of the nervous organs is not, as the ancients thought, the result of a vegetative elongation of the primary parts of this system.

gressively complicated in the animal scale, in ascending from the inferior to the higher classes. This fact constitutes the principal anatomical proof of the plurality of the nervous system. Mr. Gall is of opinion that the grayish substance is formed previously to the medullary; but according to M. Serres, this is true only with regard to the encephalon. According to the researches of Tiedemann, and other anatomists, the medullary substance appears always before the cortical; and this opinion appears to have the most probabilities in its favour.* Be this as it may, it is certain that the nervous substance passes through all the intermediate gradations between fluids and solids, being soft in infancy, and acquiring consistency by degrees. The growth of the nervous organs is effected by interstitial nutrition, and by the deposition of layers upon their surfaces, which are, apparently, secreted by the cellulo-vascular membrane by which they are covered. This growth, which is extremely rapid during fœtal life, becomes gradually slower after birth, until it is finally converted into a simple nutritive process, which itself diminishes, so that at length in old age the organs of which we are treating, have sensibly lost a share of the volume which they had acquired in adult age.

Vital properties and functions.—The nervous system is essentially sensible, but in such degrees and conditions as vary according to the different parts of which it is composed. It is to its presence in the other organic systems that are owing the phenomena of the sensibility which they enjoy. This sensibility of the organic systems is nothing but a modification of a property belonging exclusively to the nervous system—a property, which physicians have designated by the names of vital energy, nervous power,

* The circumstance which has led physiologists into error as regards this subject is, that in the fœtus, the medullary substance is slightly coloured, which is owing to its being more penetrated by the fluids during pregnancy than at any other period.

and by virtue of which, it animates the whole animal economy, and performs the most important functions.

Physiologists have at all times endeavoured to ascertain the nature of this property: how far they have succeeded will appear from the statement of the principal hypotheses, after we shall have described, in a general manner, the actions which depend upon it.

The nervous system is the apparatus of *innervation*, a multiple function, at least as to its results, by which it animates all our organs, presides over all their vital actions, both voluntary and involuntary, transmits and receives the sensorial and affective impressions, and is the agent of the operations of intelligence.

Every part of the nervous system has its determinate function. In the inferior animals, the small apparatus which compose this system, are independent of each other, and their actions are less rigidly specified; but in ascending the scale to the higher classes, we find the functions are multiplied in proportion as the nervous system becomes more complicated; at the same time that these functions, though always distinct, become less and less independent, and are placed, moreover, under the influence of a centre of action, whose integrity is necessary to their performance and regularity. This physiological centre of action, to which we have just alluded, is the encephalon, and particularly the medulla oblongata, upon which depend all the other parts of the nervous system, as well as the functions which they perform, in proportion as they have less for their object the nutrition of the individual.

The grayish substance of the nervous tissue, as has been demonstrated by Mr. Tiedemann, increases the activity of the medullary, by concentrating a greater quantity of blood towards the parts where this activity is more essentially necessary: thus the substance of which we are speaking is very abundant in the medulla spinalis, at the origin

of the nerves, and more so in proportion as these are larger.

Physiologists have not been contented with merely referring the faculty of the senses and innervation to a peculiar property of the nervous system, but they have also endeavoured to ascertain the nature of these functions. The hypotheses that have been advanced upon this subject, may be reduced to two principal ones, both very old. According to the first, which has had the smallest number of supporters, the nerves perform their functions by the centripetal and centrifugal transmission of vibrations, excited in the one case by external agents, and in the other by the brain, the point of egress of innervation and volition. Independently of the fact that this hypothesis is founded upon no direct experiment, it would be entirely inadmissible from the circumstance, that the nerves are too soft to perform the office of vibrating cords. The second supposition has had by far the greatest number of partizans, and ranks amongst its number, the most celebrated physicians of both ancient and modern times, and amongst others, the immortal Galen, Baglivi, Boerhaave, Haller, &c. This hypothesis consists in the admission of a subtile fluid which is secreted by the brain, and is designated by the names of nervous fluid, animal spirit, and pervades the nerves with the greatest rapidity, from their cerebral to their peripheral extremity, and *vicé versâ*; transmitting to the centre of the nervous system the impressions which are received by the sentient extremities of the nerves, and carrying to the organs, the volitions and the nervous influx emanating from the brain. Some have even gone so far as to imagine there are two fluids, destined, each to one of these motions, and so subtile, that they might traverse the same nervous cords, in an inverse direction at the same instant; while other physiologists, to explain the differences of the sensations in the brain, and of the volitions, &c., which are derived from it, have combined the two hypotheses, and have

attributed the first to vibrations, and the second to animal spirits. Finally, this association of hypotheses, has been inverted, and the hypothesis of animal spirits has been modified in various ways. No sooner was this admitted, than physiologists, anxious to ascertain its nature, advanced the most absurd and ill founded propositions; so that the only one, which is at all plausible and worthy of our attention, is that which compares the nervous agent to the electric fluid.

In the present day, physiologists are contented with observing the laws of innervation, and, if they go beyond this, it is with the view of drawing conclusions from the remarkable analogy which exists between certain effects of electricity upon the animal organization, either dead or living, and the vital phenomena, which allow us to presume the existence of an imponderable agent, which presides over, and regulates the functions of the nervous system.

SECTION 2.

Of the Nervous Centres.

ARTICLE 1.

Of the Cerebro-Spinal Centre.

Definition.—By the term cerebro-spinal, we understand, with most modern authors, the mass of nervous substance which is contained within the cavities of the cranium and the vertebral column.*

* We must recollect that this mass comprehends, according to Messrs. Gall and de Blainville, a series of ganglia, so many centres of small systems or nervous apparatus, and having, according to the latter physiologist, a common centre—the spinal marrow: these divisions, however various they may be, are not in contradiction with the ancient denomination of *cerebro-spinal centre,*—a collective denomination which is applied to every division of this continuous mass.

Division.—The cerebro-spinal centre is composed (*a*) of the medulla spinalis; and (*b*) of the encephalon, which comprehends the medulla oblongata, the cerebrum and cerebellum.

Situation.—(*a*) The medulla spinalis is situated within the vertebral canal which is formed by the vertebræ of the neck, the back, the loins, and the sacrum; but in the human subject, it extends only from the superior part of this canal to a level with the second lumbar vertebra.

(*b*) The encephalon is situated at the superior part of the medulla spinalis, with which it is continuous, and fills completely the cavity of the cranium.

Form and arrangement.—(*a*) The spinal marrow is a large nervous fasciculus, irregularly cylindroid, divided into two lateral symmetrical halves, by two fissures which extend throughout the whole length of its anterior and posterior surfaces. Each lateral half comprehends two fasciculi, an anterior and a posterior, whose line of demarcation is marked out by the insertion of the ligamentum denticulatum. The spinal marrow is more voluminous superiorly than inferiorly, but its decrease is by no means uniform: it enlarges where it gives off the nerves, and this in proportion to the size of the nerves which are separated symmetrically from its lateral parts, to the amount of thirty pairs. Superiorly, the spinal marrow enlarges considerably in entering the cranium, where it begins the encephalon under the name of the *medulla oblongata.* Here it presents three pairs of lateral and symmetrical fasciculi: the anterior, which is disposed on the sides of the mesian fissure, constitutes the pyramidal fasciculi, which, after having interchanged fibres, form the peduncles and hemispheres of the cerebrum;* the second pair comprehends the middle fasciculi,

* We ought not to understand by the word "*to form,*" a real vegetative growth; it is merely expressive of the order of development and of the connexion of the different parts of the encephalon.

which are situated on the outside of the preceding, and which, being reinforced by the corpora olivaria, terminate in the tubercula quadrigemina; the third pair or the posterior fasciculi, are strengthened by the corpora restiformia, and form the cerebellum and tuber annulare, which embraces the base of the medulla oblongata. All these fasciculi give rise to smaller ones which communicate with, and establish relations between, every part of the encephalon. —The encephalon, regarded as a whole, constitutes a lobulated mass, irregularly hemispherical, composed of symmetrical portions, presenting depressions and corresponding eminences, and, in short, a very complicated structure, for a minute description of which, we must refer to descriptive anatomy. *The medulla oblongata is the only part of the encephalon that gives origin to nerves.*—The encephalo-rachidian mass is surrounded and protected by three kinds of membranes; the external belongs to the fibrous system and is termed the dura mater; the middle is a kind of serous membrane, and is called the tunica arachnoides; the internal is the pia mater, a very delicate cellulo-vascular net-work, applied immediately upon the nervous masses, lining all the sinuosities upon the surface of the encephalon, and dipping into the anterior and posterior furrows of the spinal marrow. We must recollect that Mr. Gall considers the medulla spinalis and the encephalon as a series of ganglia connected together by intermediate fasciculi, and that M. de Blainville professes a nearly similar opinion, with the exception that he regards the spinal marrow as a single ganglion—the centre of all the others; and reduces the encephalic ganglia to seven pairs, as we have already seen in the preceding section.

Texture.—It is only in the cerebro-spinal mass that we observe the two kinds of nervous substance, the white and the grayish. Their relations of situation and quantity vary in the different parts of this mass; thus, in the spinal marrow, the grayish substance is interiorly and surround-

ed by the white, which is disposed around it in the form of a layer:—the grayish substance is most abundant at the points where the large nerves are given off. In the encephalon, on the contrary, the grayish substance forms the exterior and cortical layer of the hemispheres of the cerebrum and cerebellum, while the white, which is surrounded by it, composes the whole interior of these parts. Besides, in the medulla oblongata, the peduncles of the cerebrum and cerebellum, &c., we meet with masses of the grayish substance, which are enveloped by white fibres, (origin of the encephalic nerves), and alternate layers of both substances, &c. In this variety of arrangement, there is but one general law—that of the continuity of the white substance throughout the whole encephalo-rachidian mass, and the insulation of the different parts of the grayish. The fibres of the medullary substance, the only ones that are at all conspicuous, are much less apparent in the cerebro-spinal mass, than in the nerves; they are parallel in the two fasciculi of the spinal marrow, which are connected together by transverse fibres, and not, as some anatomists have asserted, by a decussation of their filaments. There is nearly the same arrangement with regard to those of the medulla oblongata, with the exception that they are more divergent, and that those of the two anterior or pyramidal fasciculi are interlaced upon the mesian line. The fibres of the peduncles of the cerebrum and the cerebellum proceed in radii to form the hemispheres of these organs, and, if we may credit Mr. Gall, these *diverging* fibres, after having reached the grayish substance that forms the cortical layer of the hemispheres, are reflected upon the mesian line, under the name of the *converging* fibres, to form the corpus callosum and the commissures. This manner of observing has been disputed by Mr. Tiedemann, who regards the cerebral commissures and the corpus callosum as being derived from the cerebral peduncles. The cortical substance of the cerebrum and the cerebellum is so abun-

dantly supplied with blood-vessels, that, when well injected, it appears to be almost entirely composed of them. To judge of the vascularity of both the white and the cortical substances, it will be sufficient merely to tear them; we shall then observe that they are covered with small reddish points, which are more or less conspicuous, and are more numerous in the grayish than in the medullary substance: these points are the extremities of the small blood vessels that have been ruptured.

Characters, physical and chemical properties.—To what we have already said upon this subject in the general observations of the nervous system, we have only to add, that the consistence of the encephalo-rachidian mass is much less than that of the nerves.

Order of development, and differences according to age.—The spinal marrow is developed before the encephalon, and amongst its different parts, the medulla oblongata is the first that comes into existence; this, which is nothing but the superior portion of the spinal marrow, has added to its fasciculi in a gradual and successive manner, the cerebellum, the tubercula quadrigemina, and the cerebrum.

The cerebellum and the cerebrum are much larger, compared with the spinal marrow, in proportion as the subject is farther advanced in age; while the tubercles are much larger compared with the brain, as the fœtus is younger, and are bigeminous before they are converted into the quadrigemena. The hemispheres of the cerebellum are at first equal to the middle lobe (vermiform process), but as they increase, they greatly exceed it in size. The cerebral hemispheres form by far the larger portion of the encephalon, and project farther backwards in proportion as the nervous system is more perfectly developed. All that we have just observed with regard to the human fœtus is equally applicable to the different classes of vertebral animals.

The encephalo-rachidian mass is at first nothing but a semi-fluid substance, which subsequently and by degrees, assumes the characters of the white nervous substance, and finally unites with the grayish substance which is secreted by the pia mater. In old age the spinal marrow and the encephalon become more dense, and there is a very sensible diminution of volume.

Vital properties and functions.—Although the encephalon and the spinal marrow enjoy the highest degree of nervous energy, there are not wanting some who have endeavoured to deny the sensibility of the brain. This error would not have been committed, if physiologists had been aware of the fact that, though there are some organs which can not be rendered painful by external irritants, they may be all excited by internal causes, whether physiological or pathological.

We have already seen, that modern anatomists, in admitting the plurality of the nervous system, recognize an assemblage of distinct masses or ganglia in the cerebro-spinal centre, and attribute to each of them a determinate function, which it exercises in virtue of its nervous energy, and which is placed under the influence of a common centre. By those (Magendie) who do not consider with M. de Blainville, that the spinal marrow is the central part of the nervous system, it is regarded as the seat of general sensibility. The posterior part of the spinal marrow, some parts of the medulla oblongata, and according to some, the cerebellum, appear destined especially to the external sensations. The anterior portion of the spinal marrow, that of the medulla oblongata which gives rise to the motor nerves of the face, and, according to Magendie, the cerebellum and some parts of the base of the cerebrum, preside over the voluntary motions. Finally, the cerebrum is the seat of the internal or affective sensations and of the intellectual faculties. The spinal marrow is really nothing but an organ of transmission; perceptions and determinations

belong to the encephalon. The portion of the medulla oblongata from which originate the peduncles of the cerebrum and the cerebellum, appears to be the physiological centre of the encephalo-rachidian mass, and consequently, of the whole system. Nevertheless, physiologists have come to very different conclusions with regard to the parts of this mass which correspond to the different functions of innervation.

Pathological Anatomy.

There are observations which would induce us to believe that the brain is susceptible of undergoing a diminution of volume before old age, but it does not appear that it is ever subject to *hypertrophia*. The conformation of the cerebro-spinal masses, is sometimes altered by the pressure of tumours situated in their neighbourhood. The spinal marrow is often compressed by curvatures of the spine, and altered in its form, though most frequently without creating any disturbance in its functions. The solutions of continuity of the encephalon and the spinal marrow, when they do not terminate fatally, heal, like those of the other organs, either by immediate re-union, or by the formation of a brain-like substance, which is deposited upon the points that have been left open from the loss of substance, or by the simple separation of the lips of the wound. In cases of apoplexy and in certain cerebral disturbances, where there is an effusion of blood or serum into the nervous tissue, if the subject be young, the fluid is soon surrounded by a cyst, and is gradually absorbed;* and its parietes approximate and form adhesions so as to completely obliterate its cavity.

The organs of which we are treating are very frequently subject to sanguineous congestions, which can be readi-

* In this case, the blood is decomposed into its two elements, the clot and the serum, and becomes really a foreign body.

ly explained by the great quantity of blood which they receive, and by the facility with which it exalts their activity. Inflammation of these organs is by no means a rare disease, and is generally accompanied by that of the meninges. Inflammation of the encephalon and medulla spinalis is characterized by the redness and softening of their substance, and sometimes, by suppuration, ulceration, and even gangrene. The sub-inflammatory state of the nervous central masses may also give rise to the secretion of purulent matter, which is sometimes collected in a single abscess, in the substance of the organ, and excites the formation of a cyst in which it remains for a variable time; at other times, the secretion is nothing but serum, which is collected either in the ventricles of the brain, or in the nervous substance itself, or between the organ and its envelopes: when this is the case, it constitutes what physicians call acute hydrocephalus, a disease which differs from chronic hydrocephalus, inasmuch as the latter, which is most generally congenital, is not accompanied by any inflammatory process. When this affection attacks the spinal marrow and its coverings, it is termed *hydro-rachitis,* of which the disease termed spina-bifida is a remarkable variety. In consequence of the chronic phlegmasiæ, the cerebro-spinal centre is also sometimes affected with tuberculous, schirrous and carcinomatous degenerations, fungous growths, and fibrous, fibro-cartilaginous, and osseous transformations. Hydatids are also found in some instances in the ventricles of the brain, and even in the substance of the encephalon and the spinal marrow. These organs are often subject to considerable softening, attended with a very variable change of colour; in many cases this alteration is evidently the result of chronic inflammation. Induration of the encephalo-rachidian mass is another disease which exists either by itself, or in union with the preceding. The indurated substance, sometimes perfectly homogeneous, and, in appearance, inorganic, resembles coagulated albu-

men; at others, however, it is more evidently fibrous. This alteration appears to be more peculiar to the white substance. The brains of idiots, epileptics, &c. are frequently indurated and softened to a greater or less extent.

The encephalon and spinal marrow are by no means exempt from mal-conformations: the entire absence of these organs, especially of the encephalon or some of its parts, is not an unfrequent occurrence. From the existence of the rest of the nervous system, under these circumstances, it is evident, that every part of it is independent as regards its development and origin. In the early age of the fœtus, the spinal marrow presents a longitudinal groove on its posterior surface, and subsequently a central canal; sometimes we observe the one or the other of these arrangements at birth; at others, this organ is entirely wanting, and in its stead, the pia mater forms a canal which is filled with a fluid, and gives insertion, as it naturally does, to the roots of the spinal nerves.

Amongst the defects of symmetry which are sometimes, though rarely observed, between the different parts of the nervous central masses, we may notice the disproportions which occur between the lobes of the cerebrum.

ARTICLE 2.

Of the Nervous Ganglia.

Definition.—The nervous ganglia are small masses, irregularly rounded, and situated on the course of the nerves.*

* We have seen that Gall and De Blainville have also applied the term ganglion to the divisions of the cerebo-spinal masses; this generalization, a natural consequence of their manner of regarding the nervous system, gives this expression an exclusively physiological sense: but it should not be used when we consider the ganglia in a less exclusive point of view—under that of their structure.

Division.—The ganglia are divided into two classes; the first comprehends those which belong to the cerebro-spinal nerves, and the second those which occur in the course of the trisplanchnic nerve: the latter may again be subdivided into those which form a double series upon the sides of the vertebral column, and into those which are more immediately upon the mesian line.

Situation.—The nervous ganglia are found exclusively in the head, the neck, and in the cavities of the thorax and abdomen; there being none in the extremities. The ganglia of the first class occur near the central extremity, or origin of some of the encephalic, and at the posterior roots of all the spinal nerves. Amongst the ganglia of the second class or of the trisplanchnic nerve, some are lateral, and placed in a double series upon the sides of the anterior part of the vertebral column, and are designated by the names of the cervical, the thoracic, the lumbar and the sacral ganglia; in this enumeration ought to be included the small coccygean ganglion, which, though it is single and situated upon the mesian line, belongs to this series. The other ganglia of the second class are more immediately upon the mesian line, and are termed the cardiac and semi-lunar.

Form and volume.—All the spinal ganglia are of an oval form; amongst the others, some are oblong, others irregularly globular, and, in a word, of a very different form. Their volume varies from that of a lentil to that of an almond.

Structure.—On dividing of the ganglia, their tissue appears at first sight to be homogeneous; but after they have been subjected to maceration for some time, we find that there are two substances, that contribute to their composition: the one is white or medullary, and is disposed in filaments in the same manner as in the nerves; the other is of a grayish red, somewhat pulpy, different from the grayish substance of the encephalo-rachidian mass, deposited in cells, and firmly adherent to the medullary filaments, and

more consistent in the ganglia of the trisplanchnic than in those of the medulla spinalis.

The medullary filaments are evidently the continuation of those which constitute the nerves upon whose course the ganglia occur. In entering the ganglia, the cords are deprived of their neurilema, and are divided into filaments, which, after having plunged into the grayish substance with which they are intimately connected, especially in the ganglia of the trisplanchnic, are separated from each other to re-unite and anastomose in such a manner as to present a very complicated arrangement in the ganglia of the second class, and sufficiently simple in those of the first. The medullary filaments, being again united with the cord, issue from the cerebro-spinal ganglia by the extremity opposite to that by which they entered, while, in the ganglia of the trisplanchnic, the points of entrance and of egress of these filaments are in very different relations of situation. All the nervous ganglia are enveloped by a more or less dense membrane which, in the spinal, has the solidity of fibrous tissue, while in the other ganglia it is merely a membraniform layer of cellular tissue. The blood vessels of the ganglia are exceedingly numerous, and most of them send branches to their envelopes before they enter the ganglia themselves.*

Characters, physical and chemical properties.—The ganglia are of a grayish red colour, which is most conspicuous in those of the trisplanchnic, which are also harder than the others. When exposed to the action of the acids and of boiling water, they are at first hardened and final-

* In comparing these details upon the structure of the ganglia with what we shall hereafter say with regard to the nervous plexus, we shall see whether the relations which exist between them will justify the opinion of Scarpa, and other authors who regard the terms ganglia and plexus as synonymous. The texture of the first is evidently more complicated than that of the second, and their uses, moreover, do not appear to authorize this approximation.

ly softened; they are slowly dissolved by the alkalies. They resist for a long time the putrefactive process; and, according to Lobstein, are converted into a kind of adipose substance after long continued maceration.—The reddish substance of the ganglia does not consist of fat, as has been asserted by some who have adopted the opinion of Scarpa upon this subject. According to the chemical researches of Wutzer and Lassaigne upon the composition of the ganglia, they contain less adipose substance than the nerves, and much less than the brain, but on the contrary more albumen and gelatine.

Development and differences according to age. The spinal ganglia come into existence before any of the others, and even before the rest of the nervous system, with the exception of the nerves which belong to them. The ganglia of the trisplanchnic are not perceptible before the third month of uterine life: they are all from the beginning of nearly the same consistence which they present during the course of life. In old age and decrepitude they become smaller, harder, and of a fainter colour.

Vital properties and functions.—All the ganglia, both of the cerebro-spinal and of the trisplanchnic order, are destititute of contractility, and the nervous energy appears to be distributed to them in the same manner as to the other portions of the nervous system; though it seems to be more energetic in the spinal ganglia than in those of the second class, at least, if we may judge from the severe pain which accompanies their mechanical or chemical irritation; while those of the trisplanchnic are entirely free from pain when they are the seat of irritation brought on by some internal cause.

The history of the functions of the ganglia is still involved in the greatest obscurity. According to some, such as Meckel and Scarpa, they are destined to collect and blend the nerves or the nervous filaments; others, such as Vieussens, Winslow, Reil, Bichat, and others, regard them as focal centres of the nervous action, presiding over those func-

tions of innervation which are independent of volition, that is, over the actions of vegetative life. This opinion, which does not concern the ganglia of the trisplanchnic, is that which is most generally adopted at the present day. Many suppose, also, that the ganglia arrest, to a certain degree, the impression which they receive from the nerves which traverse them; that they concentrate for distribution, the nervous energy emanating from the medulla spinalis, and that in this manner the trisplanchnic system is rendered independent of the cerebro-rachidian masses: we ought not, however, as the authors to whom we have just alluded, exaggerate this independence, which is merely relative. As yet we are entirely ignorant of the functions of the encephalic and spinal ganglia; M. de Blainville considers them as the centres of the nerves to which they belong.

Alterations.—This part of the history of the ganglia is still involved in the mists of obscurity. Several authors, and amongst others Mr. Lobstein, have observed inflammation of these organs in several diseases, such as tetanus, pertussis, and in some of the abdominal neuroses. Bichat once found the semi-lunar ganglion more dense, and in another instance more voluminous than natural: this last anomaly was accompanied by the presence of a cartilaginous substance in the centre of the small organ: the subject that presented it had died in consequence of a periodical mania. Anatomists have also observed cases of hypertrophia and atrophia of the ganglia of the trisplanchnic; and, indeed, it would appear probable that most of the abdominal neucroses depend upon an alteration of these organs.

SECTION. 3.

Of the Nerves.

ARTICLE 1.

Of the Cerebro-Spinal Nerves.

Definition.—The cerebro-spinal nerves are the white cords, which are connected by their central extremities to the substance of the encephalon or the spinal marrow, and terminate, after successive ramifications, in certain organs which are more or less near the periphery of the body.

Division.—We may divide the nerves, according to the seat of their central extremity, into encephalic and rachidian; according to the manner in which they are detached from this extremity, into nerves with a double, and into those with a single root; and, finally, according to their functions, into the sensitive, motor, and mixed. Each of these last divisions is again subdivided before it comes under the last term of specification: this subdivision can not be pointed out on the present occasion without anticipating some of the subjects of this article.

Situation.—The central extremity of the nerves of which we are treating, is situated within the cavities of the cranium and the vertebral column; and the other approaches the periphery of the body in proportion as the nerves ramify.

Conformation.—In consequence of their numerous anastomoses, the cerebro-spinal nerves, considered as a whole, represent the form of a grand net-work, which is much more symmetrical in its two lateral halves, in proportion as it approaches the nervous centres. Their particular individual form is generally cylindrical; some of them, however, are flattened and ribband-like. Examined with a

magnifying glass, their surface presents small spiral folds, which belong, however, merely to the neurilema.

Central extremity, improperly called the origin of the nerves.—All the encephalo-rachidian nerves communicate by their central extremity with the spinal marrow, or the medulla oblongata; there being none detached either from the cerebellum or from the brain properly so called. The nerves are always implanted in the grayish substance of the spinal marrow, and the medulla oblongata, and may be traced farther than the point where they are separated. They do not intercharge filaments at their *origin*, as has been supposed by those who have endeavoured to explain in this manner the symptoms of paralysis, and partial convulsions in the lateral half of the body opposite to that in which the lesion occurred.* By the root of a nerve we understand its central extremity, and, according as it is single or bifurcated, we say that the nerve has one or two roots. All the encephalic nerves belong to the first class, with the exception of the trigeminus, which, together with all the spinal and the sub-occipital nerves, is comprehended in the second.—The nerves with double roots are attached by the one, to the anterior fasciculi, and by the other, to the posterior fasciculi of the spinal marrow. It is to the posterior roots alone that the spinal ganglia belong—the anterior roots being simply appended to them.

Course.—In receding from their central extremity, the nerves are successively divided into branches, smaller branches and filaments, by the simple separation of the fasciculi and the cords, by the union of which their trunk is composed. In their course, the nerves form connexions either between themselves, or with the neighbouring nerves, by simple anastomoses, or by a kind of complicated interlacement, termed *plexus*. The anastomoses take place by the

* The optic are the only nerves which decussate, and this only in a partial manner, and after their separation from the encephalon.—In fishes this decussation is complete.

junction of two nerves, which are very intimately united by the continuity of substance, and are finally confounded with each other. The plexuses are anastomotic unions between several nerves which converge towards one common point: these anastomotic junctions are formed in such a manner, that the nerves which issue from the plexus consist of filaments which are derived from all the nerves that enter into the formation of the plexus. The cervical, lumbar, sacral, and sciatic plexuses are the principal of the cerebro-spinal system. The nerves generally retain the same volume from their origin to the place where they are divided; and the aggregate of their divisions presents a greater volume than that of the trunk from which they are derived.

Peripheral extremity, or termination.—After repeated and numerous ramifications, the cerebro-spinal nerves terminate in the integuments, in the organs of the special senses, in the exterior muscles, in the arteries of the parts which are subject to the influence of volition, &c. When they have arrived at their termination, the nervous filaments are deprived of their neurilema, and become sensibly enlarged: and this is all that we know positively upon this subject. Amongst the anatomists that have endeavoured to penetrate farther, some have supposed, but have never demonstrated, the existence of a kind of fusion of the nerve in the substance of the organ in which it terminates; others have said, that the nervous filaments, after they have arrived at their termination, are reflected upon themselves, and return to the branch from which they have been derived.

Structure.—At first sight, the nerves seem to be composed of a certain number of cords which are divisible into filaments of great tenuity: these are composed, 1st, of a white nervous substance, disposed in parallel fibres;* and 2d, of a

* According to the recent observations of Prevost and Dumas, the nerves are composed of a very great number of parallel filaments which are of equal size, and are flat and continuous throughout the whole length of

membranous sheath or envelope termed *neurilema*. All the filaments which enter into the composition of the nervous cords, have, besides their proper neurilema, a common one; and in the same manner all the cords which enter into the composition of the nerves have a general neurilema.

The nervous cords are placed upon each other, give off filaments of communication, and present a plexiform union: the same arrangement is found between the filaments, which, by their union, constitute the cord; so that neither the one nor the other retain the same situation throughout the whole extent of the nerve.

Towards the central extremity of the nerves, the neurilema leaves first the filaments, then the cords, and where the nerve is continuous with the pia mater, the general neurilema alone remains. It results from this arrangement, that when a nerve is torn from the central mass, its interior part will break before those which are strengthened by the general neurilema, and leave a projection, which is believed by some to be destined for the insertion of the nerve. We have already seen that the neurilema leaves the nerve entirely at its peripheral extremity.

The nerves are surrounded by a layer of cellular tissue, which penetrates between their cords and filaments, so as to unite them mutually together. The neurilema itself is nothing but a condensed cellulo-vascular tissue, which some anatomists have placed in the fibrous system. No lym-

the nerve. Each filament consists of four elementary fibres; two external, and well marked, and two middle and less distinct. These fibres are formed each of a series of globules, like those of every part of the nervous system. Bogros asserts that he has demonstrated by minute injections, which do honour to his skill, that the nervous pulp is hollow in the centre of the nerves. His experiments have been repeated by other anatomists, but not uniformly with the same results. We are therefore at present unable to decide, whether the canal admitted by Bogros, does really exist before the injections which render it obvious, or whether it is merely the result of these injections.

phatics can be traced into the substance of the nerves; but their blood vessels are very numerous and penetrate the neurilema as far as the nervous filaments.

Characters, physical and chemical properties.—The cerebro-spinal nerves possess but a slight degree of elasticity, are of a faint rose colour, and owe to their neurilema the slight degree of tenacity which they enjoy. The dilute acids, especially the nitric, dissolve the neurilema, and expose the nervous pulp, while the alkaline solutions destroy it and leave the neurilema untouched: it is this knowledge of the modus operandi of the acids and alkalies upon the nerves, that has furnished Reil with the means of analysing and detecting the anatomical elements which contribute to their structure. The medullary substance of the nerves yields a greater quantity of albumen, but less of the fatty substance, than the encephalo-rachidian masses.

Development.—The cerebro-spinal nerves, are the first parts of the nervous system of the embryo that are brought into existence. In the fœtus, they are proportionably more vascular than they are subsequently, but their structure is indistinct, and their neurilemic part appears to exceed the medullary, which is nothing but a mere liquid. The volume of the nerves is much greater in proportion to that of the encephalo-rachidian centre, as they are examined near the period of conception. In old age, they are smaller, more dry and firm, than in adult life, at the same time that their vitality is less energetic.

Vital properties and functions.—The nervous energy of the organs of which we are treating, is rendered evident by the violent pains and the muscular contractions which are occasioned by their artificial or morbid irritation. This power is inherent in the nerves, and is merely called into action by that of the medulla spinalis, and the encephalon; for, when we irritate a motor nerve, that has been separated from these centres by the knife or ligature, the muscles to which it is distributed are agitated with convulsive

motions. Anatomists have hitherto been unable to trace the least sign of vital contractility in the cerebro-spinal nerves.

The nerves are the organs which transmit to the centre of perception, the impressions which they receive in the organs to which they are distributed, and carry to every part of the body the nervous power upon which depends the muscular contractility. They are thus conductors of sensibility and of motion by a double action, from the centre to the circumference, and from the circumference to the centre, during which they manifest neither the vibrations nor the oscillations that have been admitted by some authors to explain the mechanism of the functions of transmission. The rapidity with which they are performed has induced many to believe, that there is an imponderable fluid, analogous to that which produces the phenomena of electricity, and of which the nerves are the mere conductors. Several physiological experiments give support to this hypothesis. Be this as it may, however, we ought to distinguish, amongst the encephalo-rachidian nerves, those which are exclusively devoted to the transmission of motion, or the *motor nerves;* those which belong merely to the functions of the external sensations, or the *sensitive nerves;* and those which are at once conductors of sensibility and of motion, or the *mixed nerves.* The first two classes comprehend all the nerves of the head, with the exception of the fifth pair, which, together with all the spinal nerves is included under the class of mixed nerves. Magendie, however, has satisfactorily demonstrated, that even in the spinal nerves, the two orders of functions have, to a certain degree, their distinct seat; that the anterior root is destined to motion, and the posterior to sensibility.*

* Mr. Charles Bell has lately performed a great number of experiments with the view of specifying the functions of the nerves, and has obtained very important results to physiology. He divides the nerves into *regular* and *irregular:* the first, which are common to all the vertebral ani-

Pathological Anatomy.

The nerves sometimes increase in volume, in consequence of serous, gelatinous, or fatty infiltrations of their tissue; they are often compressed, flattened, or displaced, from the development of tumours in the surrounding parts, and their atrophy, which sometimes depends upon the same cause, may also be the result of the cessation of their functions, (paralysis.) When a nerve has been divided, the two extremities, if they have been separated but a small distance, are re-united by a nervous cicatrix, and the motions of the nerve, at first interrupted between the solution of continuity and the peripheral extremity, are perfectly re-established. The manner in which this re-union is effected, may be comprised under the following observations. The superior extremity of the divided nerve, in conse-

mals, preside over the general sensibility and voluntary motions, and comprise the spinal nerves, (including the sub-occipital,) the trifacial, or fifth encephalic pair, and all the nerves with a double root; the second are the nerves with a single root, and being connected with the preceding, in proportion as the *organism* is complicated, are distributed to the organs which are amply provided with the former, and preside over the special functions. Mr. Bell, having divided the branches of the facial nerve of an ass, (the portio-duro of the seventh pair of Willis) which are distributed to the nostrils, paralysed the muscles of the parts, but those only which are subservient to respiration, and the expression of the face: on the contrary, when he divided the superior maxillary branch of the fifth pair, the skin of the face was deprived of sensibility, and the subjacent muscles lost their contractility, with the exception of those which perform the motions of respiration and expression, whose nerves were left undivided. From these facts, and others of a similar nature, Mr. Bell concludes that the presence of several nerves in a part coming from different origins, has not for its object the accumulation of a great quantity of the nervous influence, but the performance of several distinct and peculiar functions. From these researches, we perceive also how favourable are the results to the doctrine of the plurality of the nervous system.

quence of the afflux of blood becoming the seat of the exhalation of coagulating lymph, begins to swell in a short time after the division, and forms a kind of firm, elongated, grayish nodule; the inferior extremity presents, in its turn, the same phenomena as the preceding; and as the tumefaction increases, the extremities approximate, and are finally agglutinated together, by means of the plastic substance which they exhaled. The enlargement which results from the junction of the two nodules remains some time; but it gradually diminishes and finally disappears. The re-union is perfectly re-established in about six weeks or two months. In this process, there appears to be a reproduction of the medullary part of the nerve, and several anatomists have asserted that they have even traced the medullary filaments into the interior of the cicatrix. What proves this fact is, that the cicatrix acquires the conducting power of the organs of which we are treating, and that when submitted to the action of nitric acid, far from being decomposed, it assumes more consistence, as is the case under similar circumstances with the nervous substance. The restoration of the functions of a divided nerve does not take place, if the separation of the extremities be too considerable, and where the re-union is effected merely by means of cellular substance. If, on the contrary, the separation is so inconsiderable as scarcely to be perceived, the action of transmission may take place, to a certain degree, from one part of the nerve to the other, from the moment the division has been effected. Inflammation of the nerves (neuritis) appears to be a more common disease than is generally believed; it is often observed in cases of neuralgia—a disease which, however, frequently presents no *appreciable* alteration of the nervous tissue. It is in part to a sub-inflammatory state of these organs that we must attribute their softening, and the tuberculous and schirrous tumours, designated collectively by the name of *neuroma*. To the same cause may also be referred the cartilaginous and osse-

ous metamorphoses of the nerves—a kind of alteration, which is sometimes, though rarely observed, and is confined to some insulated points of these organs.

ARTICLE 2.

Of the Ganglionic Nerves.

Definition.—The ganglionic nerves are those which constitute, with the ganglia of the second class, the system of the great sympathetic or trisplanchnic nerve,—those, in other words, which being situated exclusively within the trunk, form with the ganglia just mentioned, a particular order of nervous apparatus, communicating with each other and with the spinal nerves by intermediate branches, and distributing numerous ramifications to the arteries and the organs of vegetative life: hence, the distinction of the nervous system of organic life, given by Bichat to the assemblage of this apparatus.

Division.—The ganglionic nerves are distinguished into three varieties: the first comprehends those which form the communications between the ganglia, the second, those which are intermediate between the ganglia and the cerebro-spinal nerves, and the third, those which are ramified within the organs.

Situation.—The intermediate ganglionic nerves are mostly situated upon the sides of the vertebral column, parallel with its axis, and between the double series of the lateral ganglia, which extend from the head to the os coccygis. The others extend from the lateral to the mesian ganglia. The ramifications of the second variety are placed, most of them, transversely upon the sides of the vertebral column, between each lateral ganglion and the corresponding spinal nerve. The situation of the ramifications varies in each organ to which they are distribut-

ed; but, like the preceding, they belong exclusively to the trunk.

Conformation.—Considered as a whole, the ganglionic nerves by no means exhibit the symmetry of those which issue from the encephalo-rachidian masses. Béclard has justly compared the system of the great sympathetic "to a subterraneous stem or articulated root (rhizome,) which, upon one side of each bulb presents small roots, and upon the other, small branches, all of which are separated at right angles, or nearly so."

As to their peculiar form, the ganglionic nerves are not all alike: those of the second variety are rounded, and resemble, in this respect, the spinal nerves: those of the other varieties are flattened, and, besides, those of the third present this peculiar character, that instead of diminishing in volume in proportion as they ramify, they augment or diminish in different ways. All are larger in the neighbourhood of the ganglia than in the rest of their extent.

Origin.—Many anatomists have disputed whether the ganglionic nerves arise from those of the cerebro-spinal system, with which, as we have already seen, they communicate, or whether the ganglia ought to be regarded as their centres of origin. Neither of these propositions, however, is properly admissible, for the development of the ganglionic nerves is perfectly independent of that of the other parts of the nervous system; but in applying, as we have already done, to the term *origin*, the signification of *central extremity*, we ought to place it in the ganglia of the great sympathetic, and consider the nerves which pass from them to the organs, as forming with the first so many small nervous apparatus, which communicate with each other and with the encephalo-rachidian nerves. At this central extremity, the medullary filaments of the ganglion are continued with those of the nerve, and moreover, the envelope of the first being extended upon it, adds firmness to their mutual adhesion, and, by covering the second to a

small extent, gives it the appearance of a part of the ganglion, elongated in the form of a cord.

Course.—The ganglionic nerves of the first variety pass directly, and without presenting any thing peculiar, to the cerebro-spinal nerves. The same arrangement obtains with regard to the cords which form the communications between the ganglia, and especially with those, which, being placed at each side of the vertebral column, form with these what is called the trunk of the great sympathetic nerve. As to the nerves which pass from the ganglia to the arteries, and to the different organs of the head and neck, and to those of the chest and the abdomen, they are ramified in their course and form more or less intricate plexuses, either before they have reached their destination, as in the cardiac and solar plexuses, or after they have arrived upon the parietes where they decussate with the filaments coming directly from the ganglia. In their course, as well as in the plexuses, these nervous filaments are connected with the ramifications of the encephalic nerves, and particularly with those of the pneumo-gastric.

Organic extremity or termination.—The ganglionic nerves (and we speak here only of those of the third variety,) terminate in the parietes of the arteries of the trunk, in the heart, the digestive canal and its appendages, and in the urinary and genital organs.

Structure.—The ganglionic nerves of the first variety, and even those of the second, are formed of small medullary fibres, and of a neurilemic envelope, which is more dense at their extremities, where it is sometimes continuous with the envelope of the ganglia, more thin and delicate at their middle part, and more intimately connected with the small fibrillæ than that of the cerebro-spinal nerves. These last are very difficult to be separated from each other, and are, moreover, plunged into the peculiar grayish red substance, which we have already described as belonging to the ganglia. Notwithstanding the differences which we have just

pointed out between these nerves and those of the cerebro-spinal system, both resemble each other with regard to form, colour and structure: the branches which connect the ganglia with the spinal nerves, resemble these in particular, and much more in proportion as they approach them. As to the nerves of the third variety, we can not distinguish in them any fibrillæ, and they appear to be entirely formed of a soft reddish pulp, around which we can not demonstrate the existence of a neurilema.

Characters and physical properties.—The nervous cords which pass from the ganglia to the cerebro-spinal nerves have a whitish appearance, are less firm and resisting than these, and appear to be destitute of elasticity. Those which connect the ganglia together are of a grayish colour, have more of the bulbous substance, and are somewhat less tenacious and consistent than the preceding. The ganglionic nerves which are distributed to the organs are, with some very few exceptions, of a reddish colour, very soft and brittle.

Vital properties and functions.—The nervous energy of the ganglionic nerves appears to be less active than that of the cerebro-spinal nerves, and this in proportion as they are more frequently intersected by the ganglia. In their healthy state, this nervous power of the ganglionic nerves is not manifested, either by sensibility or contractility; but in certain diseases, they are the seat of a peculiarly painful affection.

The ganglionic nerves serve to transmit the nervous influence to the organs of the involuntary functions, but they do not convey to the centre of perception the impressions which are received by these organs; these being, under ordinary circumstances and unless the action of the nerves be stimulated by disease, arrested by the ganglia. All the ganglionic nerves, at least those of the first two varieties, contribute to the phenomena of sympathy, by establishing communications between the ganglionic and the cerebro-

spinal system; but it is doubtful whether they are, as was asserted before the time of Bichat, the essential organs of the sympathies. All the nerves are, by reason of their continuity, susceptible of producing these phenomena. The action of the nerves of which we are treating, though more independent than that of the cerebro-spinal nerves, is, however, subordinate to them, inasmuch as it ceases as soon as these nerves are separated from the cerebro-spinal. The nervous influence, which is transmitted to the ganglionic nerves by the centres above mentioned, arrives in the organs only after it has been, *probably*, diminished, divided and modified by the ganglia, which distribute it. It is, therefore, to this character which we attribute to the ganglia that ought to be referred the independence of the portion of the nervous system to which they appertain.

Pathological Anatomy.—Few anatomists have paid attention to the study of the pathological anatomy of the ganglionic nerves. They have been known to be inflamed in cases of neuroses of the abdominal organs, and in subjects who have died from pertussis: they are also sometimes affected with atrophia and hypertrophia, especially when the organs to which they are distributed present the same pathological conditions.

Bibliography of the Nervous System.

Vicq-d'Azyr. Recherches sur la structure du cerveau, etc., dans les Mém. de l'Acad. des Sciences, 1781–83.

——— Traité d'Anatomie et de Physiologie, gr. in fol., avec pl. Paris, 1786.

Gall et *Spurzheim.* Anat. et Physiologie du système nerveux en général, et du cerveau en particulier. Paris, 1810–19.

Fr. Tiedemann. Anatomie du cerveau, trad. de l'allem. par *Jourdan.* Paris, 1823.

Serres. Anatom. comparée du cerveau dans les quatre

classes des animaux vertébrés, 2 vol. in 8o. avec atlas. Paris, 1824 et 1826.

Desmoulins. Anatomie des systèmes nerveux des animaux à vertèbres, etc. Paris, 1825.

Rolando. De la véritable structure du cerveau de l'homme et des animaux, et des fonctions du système nerveux; trad. de l'italien et inséré dans le Journal Physiol. expérim. tom. III.

J. et *Ch. Wenzell.* De penitiori structurâ cerebri. Tubing. 1812.

H. M. Edwards. Mém. sur la struct. élém. des principaux tissus organiques des animaux vertébrés. Paris, 1823.

Proschaska. De structurâ nervorum anat. in opera minora.

Reil. Exercitationes anatomicæ de structurâ nervorum. Halle, 1797.

Prévost et *Dumas.* Mém. sur les phénomènes qui accompagent la contraction musculaire. (Journal de physiol. expérim., tom. III.)

In this memoir are contained some very interesting details upon the structure of the nerves, a concise account of which will be found in a note in the third section of this chapter.

Bogros. Note sur la structure des nerfs (dans la Revue médec., mai 1825, p. 237.)

Haase. De gangliis nervorum. Leipsic, 1772.

Scarpa. De nervor. gangliis et plexubus. Modène, 1779.

Lobstein. De nervi sympathetici humani frabricâ, usu et morbis. Paris, 1823, in 4o. avec pl.

Brachet. Mémoire sur les fonctions du Système nerveux ganglionnaire. Lyon, 1825.

Ch. Bell. Recherches anat. et physiol. sur le système nerveux (Journal de physiol. expérimentale, tom. I. et II.)

Bell on the Nerves.

Legallois. Expériences sur le principe de la vie. Paris, 1812.

Georget. De la physiologie du système nerveux. Paris, 1821.

Breschet. Art. Acéphale, et Anencéphale du Dictionn. de Médecine en 18 vol.

Geoffroy-St. Hilaire. Philosoph. anatom., tom. II.

Pinel fils. Recherches sur l'endurcissement du système nerveux. Paris, 1822.

Lallemand. Recherches anatomico-pathologiques sur l'encéphale et ses dépendences: quatre lettres. Paris, 1820, 1823.

Rostan. Recherches sur le ramollissement du cerveux, 2e. édit. Paris, 1823.

Ollivier (d'Angers). Traité de la moelle épinière et de ses maladies. Paris, 1823.

Rochoux. Recherches sur l'apoplexie.

L. G. Descot. Dissertation sur les affections locales des nerfs. Paris, 1822.

Magendie. Expér. sur les racines des nerfs qui naissent de la moelle épinière (Journal de Physiologie expérimentale, tom. II.)

Breschet, M. Edwards et *Levasseur.* De l'influence du système nerveux sur la digestion stomacale (Arch. génér. de Méd., août 1823.)

Wilson Philipp. De l'influence du galvanisme sur la digestion, la respiration, etc. (Arch. génér. de Méd., mai 1823.)

Humboldt. Résultat d'expériences sur les actions galvaniques, etc. (Arch. génér. de Méd., octobre 1823.)

Flourens. Recherches expérimentales sur les fonctions et les propriétés du système nerveux dans les animaux vertébrés. Paris, 1824.

CHAPTER VIII.

TEGUMENTARY SYSTEM.

SECTION 1.

General Observations.

Definition.—The tegumentary system is composed of a large membrane which covers the entire surface of the body, and enters it so as to line all the cavities which communicate with the exterior world.

Division.—The tegumentary system is divided into two secondary systems, the cutaneous and the mucous.

Situation.—The teguments are placed upon the surfaces of the animal which communicate more or less directly with exterior objects: thus, after having covered the whole exterior surface of the body, it lines the mouth, the œsophagus, the stomach, the intestines, and all the excretory ducts that empty into them, the aerial passages, the nasal fossæ and all their sinuses, and the urinary and genital organs.

General conformation.—The tegumentary system, represents, by its situation, all the other organs of the body, and its general form may be compared with that which results from the union of two hollow cylinders, which are continuous by their extremities and are separated at their contiguous surfaces by an intermediate substance. This comparison is applicable only to the skin and to the mucous membrane which extends from the mouth to the anus;

it will include, however, all the teguments, if we add to the cylinders which we have just mentioned, certain prolongations or appendages, which are plunged in different points of the intermediate substance, and line the aerial passages, the excretory ducts of the glands, the genito-urinary organs, &c.

Surfaces.—The tegumentary membrane presents two surfaces, one of which is free, the other adherent: the first, which is external to the skin, and internal to the mucous membrane, is in relation in a continuous or interrupted manner with the substances that are actually foreign to the organization. The free surface presents small granular eminences, porous depressions, and horny or calcareous productions, either situated together, or scattered in different points: the adherent surface, which is internal to the skin, and external to the mucous teguments, corresponds immediately with the layer of cellular tissue, which we described in the first chapter, and, through the medium of which, this surface is connected with the subjacent organs. The adherent surface has small eminences, which are more or less prominent and correspond to the depressions on the free surface.

Structure.—In the organization of the teguments, we are to consider: 1st, the different layers of which they are composed and upon which their form depends, and 2d, their small secretory organs.

The layers which form the tegumentary membrane are five in number: they vary in a very sensible manner, in the different parts of this organ, and especially, in its two grand divisions: we shall enumerate them in pointing out their most general characters.

1st. *The dermis* or chorion constitutes the basis of the teguments, is the thickest of the layers of which we are treating, and is situated underneath them: it is formed of compact cellular tissue, which permits numerous blood vessels and nerves to ramify between its fibres.

2d. *The vascular retiform layer,* which is placed upon the dermis, is extremely thin and delicate, and results from the interlacement of the small arteries, veins and lymphatics which traverse it.

3d. *The small papillæ,* are formed by the peripheral extremities of the nerves which traverse the preceding laminæ. It is probable, that the nerves of these small nervous papillæ, which are situated upon the surface of the teguments, belong, like most of the others, to the dermis itself; and are only invested by the extremities of the nerves which traverse it with the vessels, and terminate upon its surface.

These last two laminæ are not well marked, and ought to be regarded rather as the most superficial parts of the first.

4th. The *rete mucosum* of Malpighi consists of a layer of semi-organized mucus which contains the pigment or colouring matter of the skin, and is situated between the epidermis and the superficial laminæ of the chorion. The existence of the rete muscosum, first described by Malpighi, and since by many anatomists, has been denied by Bichat and M. Chaussier; while some, and amongst others, M. Gaultier, founding their opinion upon observations on the skin of the negro, assert that it consists even of several layers.

5th. *The epidermis or scarf-skin,* is the most superficial of the tegumentary laminæ, and is by no means distinct in every part of the system of which we are treating. The epidermis, considered by some as formed of several laminæ, endowed with a certain degree of vitality, which diminishes progressively from the most internal to the most superficial, and by others, as having a squamous structure, is a whitish, semi-transparent, membraniform substance, which is moulded upon the prominences of the chorion, and is generally regarded in the present day as destitute of life, and as deposited upon the surface of the teguments by an excretory process.

The small secretory organs that are observed in the tegumentary system are known under the names of *folliculi*, *cryptæ*, &c. and consist of a species of very small, oblong or rounded cyst, terminated by a more narrow part,—a kind of neck, which performs the office of excretory duct, and opens upon the free surface of the teguments: hence, the small porous depressions which are observed upon this surface. The follicles appear to result from a simple depression of the tegumentary membrane, and are formed of the same anatomical elements, that is, of a dense capsule similar to the chorion, surrounded and pervaded by numerous vessels; of a vascular nervous net-work spread upon the concave surface of the dermis, and of excretory parts which vary according to the kinds of follicles, and which sometimes contain a pigment or colouring matter, as that which is observed in the hairs, &c. The follicles may be divided, according to the nature of their secretions, into two kinds: the first comprehends those which secrete a more or less fluid substance, and carry it to the surface of the teguments: these are the cryptæ or the follicles properly so called, whose secretions vary accordingly as they belong to the skin, or to the mucous membranes. They occur in every part of the teguments; but they are not every where equally numerous. We find them sometimes insulated, sometimes in groups, and sometimes again in regular orders. The second is composed of the follicles which are designated more particularly under the name of *bulbs*, and which M. de Blainville has called *phanères**, because their secretions, being always solid, remain apparent on the surface of the animal: these productions are, the hairs, the nails and the teeth. The bulbs occur only in certain parts of the tegumentary tissue, and are almost always collected in groups.

Characters, physical and chemical properties.—The

* From Φανερος, evident. S. D. G.

colour of the tegumentary membrane varies accordingly as it is owing to the presence of blood or to that of pigment; there being in this respect remarkable differences not only between the external and the internal teguments, (the latter have no pigment,) but also between the different parts of the same membrane. The internal membranes also vary in regard to their density and thickness; but it may be said as a general rule, that their density is intermediate between the cellular and the fibrous tissues. The teguments are susceptible of considerable extension, after which they recover their original dimensions, either suddenly, or slowly, accordingly as the distension has been ancient or recent, and accordingly as its cause disappears slowly or with rapidity. The elasticity, or rather the retractility of the tissue of the tegumentary membranes, is moreover rendered evident by the rapid separation of the borders of the solution of continuity, at the moment of an operation.—Exposed to the action of ebullition, the chorion is almost entirely reduced to gelatine, and this principle, together with a small quantity of mucus, appears to be the principal ingredient in the composition of the reticular body of Malpighi. The epidermis is insoluble in water. M. Vauquelin regards it as indurated mucus; Hatchett as coagulated albumen.* At the commencement of putrefaction, the subjacent laminæ to the epidermis spontaneously separate; and the epidermis itself is detached a few days after death by the fluids which transude through the chorion.

Vital properties.—The teguments enjoy a very active vitality. The numerous nerves which are distributed to them render them extremely sensible, but in such a manner, and in such degrees, as vary greatly according to their

* The human epidermis possesses the same properties as horn: it consists of—fatty matter, 0.5; animal matter, soluble in water, 5.0; concrete albumen, 93 to 95; lactic acid, lactate, phosphate, and hydrochlorate of potash, sulphate, and phosphate of lime, an ammoniacal salt, and traces of iron, 1.—John Ecrits, Chim. VI, 92.—S. D. G.

different parts. Their vital contractility is equally remarkable.

Differences according to age.—Wolff, Ocken, and Meckel, regarding the vitelline membrane of birds as analogous to the urachus of the mammiferi, are of opinion, that the intestinal canal arises from the umbilical cord at the beginning of the human ovum, and that the tegumentary membrane of this canal exists before any of the other organs. According to the same manner of observing, the internal tegument is formed before the external. These conclusions are far from being satisfactory, and we possess as yet no positive information with regard to the time in which the formation of the teguments begins to take place. It would appear natural to suppose, however, that they do not precede in their development the organs which they are destined to cover: thus, the skin, which at first forms only a demi-canal, is open at its anterior surface, because the anterior parietes of the trunk present an interruption at the same time. The skin approaches successively to the mesian line, in proportion as the parietes of the abdomen themselves approximate, so that the interruption only ceases after these are fully united. The teguments pass successively from their semi-liquid state to their proper consistence. Their thickness is in direct ratio with the age of the individual. The differences which exist between the external and the internal teguments, scarcely observable in the early stage of fœtal life, become more prominent in proportion as the individual advances in life.

Functions.—The tegumentary system envelops the entire mass of the body, protects it from external injuries, and establishes its relations with the exterior world: 1st, as an organ of general sensibility, and of special sensations, and 2d, as an organ of absorption, and of exhalation. The functions of this system vary in the different parts of the body—a difference which results from a difference in their organization.

The extent of the tegumentary organ, and the importance of its functions render its state of *integrity* of the highest consequence to the general health. The intimate sympathy which exists between the different parts of the teguments, renders it necessary to the health of the individual, that there should be the most perfect anatomical and physiological integrity; thus, the suppression of the cutaneous exhalation, is almost invariably followed by an increase of exhalation of some of the mucous membranes, and this superabundance of activity, or rather, the humoural congestion which takes place, may be followed by inflammation: such are the most frequent causes of bronchitis, pneumonia, and some other affections.

SECTION 2.

Of the Skin.

Definition.—The skin is that part of the tegumentary membrane which covers the whole external surface of the body.

Division.—The external teguments consist of the skin and its appendages, which are, in the human subject, the nails and the hairs.—These will be described with the appendages of the mucous membranes in the fourth section of the present chapter.

Conformation.—The skin represents the form of the body which it covers, enters into its cavities, such as the mouth, the nostrils, the anus, the urino-genital organs, &c., and becomes mucous membrane, without interruption of continuity.

The skin often presents rugæ or folds which depend upon this membrane, which, not being susceptible of contracting as much as the subjacent tissues, becomes puckered so as to accommodate itself to their retraction, and sometimes, also, owing to the loss of a portion of its elasticity in

consequence of age, the membrane can not retract when the organs which it covers diminish in volume and cease to sustain it. The other folds are those which are observed upon the skin of the articulations, and are the result of the intermittent extension which it experiences in consequence of the motions of the joints.

Surfaces.—The external or free surface of the skin is in relation with the exterior world. It is smooth and even, especially in the female, and is moistened by the perspiratory and sebaceous exhalations. We observe upon the free surface of the skin, besides the folds of which we have already spoken, and which extend through the entire thickness of the membrane, small papillary prominences, and several kinds of depressions. The prominences are either insulated, or arranged in linear order, accordingly as their direction varies; the most numerous and remarkable by the regularity of their disposition, are those in the palm of the hand and the sole of the foot. This surface also presents the orifices of the sebaceous bursæ, which are more numerous and conspicuous in the face, especially on the wings of the nose, than any where else.

Finally, the external surface of the skin presents, in certain parts, the excretions of the bulbous or phaneric follicles, that is, the hairs and the nails.

The internal or adherent surface of the skin is connected with the subjacent parts by cellular tissue, which is either loose, or very compact, accordingly as the skin is destined to perform more or less extensive gliding motions. We have already seen, in a preceding part of this work, that there are synovial capsules interposed between different organs and the tegumentary membrane to facilitate their motions. The skin is most frequently in contact with the adipose tissue; sometimes, however, it is intimately connected to the fibrous organs, and at others, to the *subcu-*

taneous muscles, which are more generally found in animals, and are more important in them than in man.*

The internal surface of the skin presents numerous, oblique, areolar depressions, containing adipose tissue, and having their base pierced by small foramina, for the passage of blood vessels and nerves: these depressions, which are almost invisible in some parts, as in the dorsal part of the hand and the foot, the scrotum, &c., are remarkably large in the palm of the hand, the sole of the foot, the back, the abdomen, &c. We observe also upon this surface, numerous small prominences, or secretory organs, which are formed by the base of the follicles of this membrane, and appear, as we have already said, to result from a depression of the chorion.

Structure.—We shall here enter into a more minute detail with regard to the laminæ of which we treated in the preceding section.

1st. *The dermis*, or the principal lamina of the cutaneous organ, is formed of a peculiar cellulo-fibrous tissue, which some anatomists have supposed to be analogous to the muscular fibre; but it appears to result from a modification of the generative tissue, less characterized than that which constitutes this fibre. The fibrous structure of this tissue is most evident in the palm of the hand, the sole of the foot, and in those parts where the dermis is connected with a layer of the fibrous tissue: we may then regard it as the most superficial part of the fibrous tissue, from which it is almost impossible to separate it.

The fibres of the dermis are indistinct on the greatest part of the trunk and the extremities, nor are they at all distinct upon the dorsum of the hand and foot, the forehead, &c. The tissue of the dermis is less compact on its internal, than upon its external surface, where it is cover-

* The platysma-myoides is the only muscle of this kind in the human subject.—S. D. G.

ed by the vascular net-work, and presents the papillary prominences which we have just pointed out on the external surface of the skin, and which are more conspicuous upon the dermis where it is denuded of its subjacent laminæ, which have a tendency to obscure them. The internal surface lies almost every where upon a layer of adipose tissue, which varies in thickness, penetrates the interstices of the dermis, and contains a great number of blood vessels and nerves: these insinuate themselves into the cells of the dermis, distribute filaments to its tissue, and terminate, most of them, upon its external surface, where they form by their interlacement the second layer of the skin. The dermis is generally white; when its vessels, however, admit much blood, it presents a faint red colour. It is very thick on the posterior part of the trunk, the external surface of the extremities, the palm of the hand, and sole of the foot, upon the cranium, &c.; more thin and smooth on the anterior part of the trunk, the internal surface of the extremities, the face, and still more delicate on the eyelids, the genital organs, the nipple, &c. The thickness of the dermis varies in these different parts from about a sixth to a twentieth of an inch. It is supple, extensible, and retractile. By desiccation it is rendered elastic like horn; by the action of ebullition it is resolved into gelatine:* under the influence of cold, of *certain* moral affections, &c., it exhibits true vital contractions. The papillæ upon the external surface, appear to favour the tactile sensibility of the skin; at least, they are more developed where this sensibility is more exquisite.

2d. *The vascular retiform layer* is merely, as we have already said, the external surface of the dermis, and not a dis-

* It is the gelatinous nature of the chorion which renders it fit for the purposes of the arts. In effect, the gelatine combines with the *tanin*, and forms an insoluble compound, which the tanner obtains by putting the dermis in contact with different kinds of bark (those of the oak, the fir, &c.,) which contain the principle to which we have just alluded.

tinct layer. Notwithstanding this, it is well developed in those parts where there is constantly a bright florid colour, as in the cheeks, and enjoys there a kind of erection, as is proved by some of the moral affections.—It is this part of the skin which is the true seat of the cutaneous exhalation and absorption.

3d. *The small papillæ,* are also indistinct from the superficial part of the dermis: they are situated on the external surface of the dermis, and are in part composed of the vascular retiform layer. The sense of touch being in direct ratio with the number of these small prominences, it is supposed that the nervous substance is more abundant there, than in the other parts of the skin; this, however, can not be demonstrated.

4th. *The rete mucosum,* which has eluded the observations of Bichat and Chaussier, notwithstanding the most minute dissections, is spread, as is asserted by those who have seen it, under the form of a mucous lamina, upon the preceding parts, and is moulded exactly upon the papillæ. This lamina, which is the seat of the colour of the skin, is much more conspicuous in proportion as the colour is more prominent. It is generally regarded as a simple lamina, but several anatomists, and particularly M. Gaultier, assert that it consists of several layers. This physiologist, drawing his conclusions from a number of experiments performed upon the skin of the Negro, asserts that the rete mucosum consists of four laminæ: the internal is vascular, and secretes the colouring matter of the skin; the second, placed immediately upon the first, is white, inorganic, and is termed *albuginea profunda;* the third is composed, like the first, of small arteries and veins united in clusters, and is impregnated with the colouring matter of the skin; the fourth, or the *albuginea superficialis,* is inorganic like the second, is secreted by the third, and covered by the epidermis. M. Dutrochet admits the existence of the last three of these laminæ, and regards the first as identical with the vascular

retiform layer on the surface of the dermis. Be this, however, as it may, the colouring matter of the skin, located by many anatomists in the dermis, and especially in the epidermis, is really intermediate to these two laminæ, without their being, however, completely foreign to it. This matter, called pigmentum nigrum, is disseminated throughout the rete mucosum under the form of globules: it may be separated by long maceration, which, in dissolving the semi-organized mucus in which it is plunged, separates it without alteration. These experiments have been made only upon the skin of the negro:* that of the European, contains but little of the pigmentum nigrum; and in the Albinoes, it is entirely wanting. The thickness and consistence of the rete mucosum are in direct ratio with the quantity of this matter: it is almost entirely composed of carbon, and appears to be of use in defending the external teguments from the rubific action of caloric, by absorbing its rays, and preventing them from entering the small papillæ: the Albinoes, therefore, are very sensible to the impressions of the solar rays, even sometimes to such a degree as to produce the vesication of their skin.

5th. The *epidermis*, the most superficial laminæ of the skin, is a very delicate membranous layer, which is perfectly moulded upon the preceding, and adheres to them intimately, first, by the hairs which traverse it; and which it furnishes with a cortical expansion; and secondly, by the small filaments which are perceived between the epidermis and the chorion, after they have been detached by putrefaction, or by immersion in boiling water. These filaments have been hypothetically regarded by some anato-

* In the negro, the rete mucosum may be deprived of its black pigment, by immersing the foot or hand for some time in water impregnated with chlorine gas: in a few days, however, the original colour will return with all its former intensity. This experiment was first made by Dr. Beddoes, and has since been repeated by many physiologists.

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mists as exhalent and absorbent vessels. Béclard has justly thought that we might consider them as mucous *tractus*, formed by the intermediate substance between the chorion and the epidermis, and rendered more fluid by the incipient stage of decomposition.

The epidermis covers the entire surface of the skin, like a kind of dry varnish, and penetrates, by becoming more thin and delicate, into the sebaceous and phaneric follicles. The structure of the epidermis has been a cause of much dispute amongst anatomists. While some, as M. Mozou, of Turin, Mascagni, Gaultier, and others, have attributed to it a more or less intricate organization; others have supposed that it is composed of scales, which are arranged so as to overlap each other; but neither of these opinions, however, appears to be well founded. M. de Humboldt, who examined the epidermis with a very powerful microscope, was neither able to detect the vessels of which some physiologists have asserted it was formed, nor the least appearance of organization. The epidermis appears to be a concrete substance exhaled upon the surface of the rete mucosum, or, if we wish, the most external part of it.

Is the epidermis porous? This we might at first sight be induced to believe, by looking at the drops of sweat which are discharged from certain points of this layer, and which are depressed so as to assume the appearance of perforations, and which are, moreover, much more transparent than the parts which separate them, if a portion of epidermis be placed between the eye and the light. Leuwenhœck believed in the existence of these perforations; Bichat thought that they were oblique, and that in consequence of this only they were imperceptible; but repeated observations, and amongst others, those of M. de Humboldt, do not justify this opinion; nor can there be any pores discovered either by inspection or direct experiments, and the epidermis appears only to be more thin and delicate in the points to which we have just alluded than any where

else. Besides this difference of thickness, common to the epidermis on every part of the surface of the body, we shall find that there are others, if we compare this layer in the different regions; thus, it is more thick in the palm of the hand, and especially in the sole of the foot,—a difference which ought not to be attributed exclusively to the constant pressure which these parts experience, because it exists already, though in an inferior degree, in the fœtus. Wherever the epidermis is very thick and firm, it appears to be composed of several laminæ: it is white in the European, grayish in the Negro, semi-transparent, supple, and less elastic than the chorion, and this in direct ratio to the humidity which penetrates it. The epidermis is faintly hygrometric, and by immersing it in water, it becomes opake and thickened,—changes which take place more rapidly when this fluid is hot. It resists, for a long time, the putrefactive process, and completely the action of ebullition: by treating it with the nitric acid, it becomes yellow, and is afterwards reduced to a pulpy substance; and by exposing it to the action of the salts of potash and soda, it is converted into saponaceous compounds. These chemical characters have induced anatomists to regard it as an albuminous substance. The epidermis is completely destitute of vitality, and enjoys a mere mechanical character in the organization, in diminishing, by its interposition between the dermis and surrounding bodies, the impressions of these upon the nervous part of the skin. Notwithstanding its feeble hygrometricity, the epidermis gives passage to the perspiratory fluids, and allows, to a certain extent, foreign substances, either liquid or gaseous, to enter the system.

The skin is supplied with a great number of sebaceous and bulbous follicles: we shall speak of the latter when treating of the solid parts which they produce. As to the first, we do not know whether they are spread throughout the whole extent of the skin: be this, however, as it may, they occur in great number on the face, around the alæ nasi, in

the groins and axillæ, around the anus and on the most hairy parts of the body. The sebaceous follicles are, as we have already said, very small vesicles which open on the surface of the skin, are destitute of epidermis, and appear to result from the simple depressions of this membrane. They secrete an unctuous substance, which often accumulates, becomes inspissated, and may be discharged by pressure, under the form of small *worms:* in the meatus auditorius externus this fluid is termed *cerumen.** This unctuous fluid protects the skin from the action of the fluids applied upon its surface, and performs, in this respect, the same character as the epidermis.

Characters, physical and chemical properties.—The different laminæ which compose the skin, constitute, by their union, a membrane whose colour varies according to the different races of the human family, from white to black, passing through all the intermediate grades; being supple, elastic, more thick in people of colour than in the European, and being with difficulty penetrated by the fluids which are in contact with its free surface, and composed in great measure of gelatine and a certain quantity of albuminous mucus.

Vital properties.—The skin enjoys an exquisite sensibility, which is owing to the great number of nerves which are spread upon the external surface of the dermis, and is more conspicuous in those parts where the papillæ are very numerous, and, cæteris paribus, in those where the epidermis and the rete mucosum are thinner than in the other parts. The external tegument is susceptible of very sensible vital contractions, which give it the peculiar appearance vulgarly known by the name of *wrinkles.*

Differences according to age and sex.—The skin is not

* According to Vauquelin, the cerumen of the ear is composed of the following ingredients: 1st, albumen; 2d, an inspissated oil; 3d, a colouring matter; 4th, soda; 5th, phosphate of lime.—Fourcroy, ix. 373.

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distinct until about the end of the second month of pregnancy, at which period the epidermis is already visible. At first the skin is destitute of colour, and of such tenuity as to render it perfectly transparent, but it soon assumes the faint red colour which it exhibits at birth. The sebaceous cryptæ appear at half the term of uterine life; during the whole period of which, the external surface of the skin, being in contact with the amniotic fluid, is covered by an unctuous layer. As we advance in age, the skin, which at birth is nearly of the same colour in all the different races, assumes the characteristic and distinctive colour of each. The colour of the skin is first observed on the genital organs, around the nipple, the eyes, the nails, and finally, at the end of the first week, it extends over the whole body. This membrane, which is very delicate and smooth in the infant, becomes more thick and consistent as the individual advances in life. In the male, it becomes dry, and loses its retractility with age; while, in the female, it retains almost entirely the delicacy and smoothness which it possessed in infancy.

Functions.—The skin is the organ of the tactile sensations and of touch. It exhales two kinds of fluid, which are eliminated by its free surface; the one is the sebaceous fluid which we have already described; the other is more thin and is continually discharged under the form of vapour, and sometimes under that of fluid, constituting what is termed sweat: this fluid is probably discharged through the points of the epidermis, which, in consequence of their thinness, have been considered by some physiologists as pores. The cutaneous vapour or insensible perspiration is remarkably abundant, and is, in this respect, to the pulmonary transpiration, as eleven to seven: it contains carbonic acid gas and an odorous animal principle. When it becomes too abundant to evaporate on the surface of the skin, and is presented under the form of small drops, its composition appears to be somewhat different and more

complex.* According to the analysis of M. Berzelius, sweat is composed of the hydrochlorate of potash and soda, of the lactic acid, the tartrate of soda, and a small proportion of animal matter. The sweat emits a peculiar odour which differs in different individuals, and is stronger in infancy than at any other period. There are some facts which would induce us to believe that the subcutaneous fat is also exhaled by traversing the skin, if not constantly, at least when the temperature of the body is considerably elevated. The skin absorbs, but slowly and in small quantities, the fluids which are put in contact with it; so that it is improper to regard it as an important organ of absorption. The small degree of permeability of the epidermis presents an obstacle to this function, which is exceedingly active when the epidermis is removed. In man, the skin can scarcely be considered as an organ of defence; though it performs this function by means of its epidermic layer, the hairs and the nails.

Pathological Anatomy.

When the skin suffers considerable and long continued distention, as happens during pregnancy, the fibres of the dermis are not only elongated and separated, but some of them are actually torn. When the membrane recovers its original state, these fibres cicatrize: hence the white striæ which are constantly found on the skin of the abdomen of women who have had children. Another effect of distention is the production of folds and wrinkles, which vary in size according to the degree of elasticity of the skin, and consequently, also, according to the age of the individual.

* Perspiration, whether sensible or insensible, is a very important means of depuration, the suppression of which produces some of the most fatal diseases. It has for its object the equilibrium of the temperature of the body, by carrying off the superabundance of caloric which protects the system: so that those persons who perspire but little are more frequently affected with head-aches than others.

The free surface of the teguments often presents different kinds of growths, which vary both in volume and form. They are generally termed *warts*, and are most frequently seated in the dermis, of which they are merely an unnatural development: the secondary syphilitic affections appear rather to be seated in the vascular retiform lamina, than in any other part of the dermis. The horny productions of the skin, of which there are several varieties, are sometimes met on the tissue of the subcutaneous cicatrices: they have also been known to arise from the sebaceous follicles; but the most common are those, which, in consequence of continual pressure, are formed in the epidermis, or rather they are a preternatural development and harding of the epidermis. In this manner are *corns* produced, which are small, hard, rounded, horny elevations, and which, being placed at first on the surface of the dermis, create the most severe pain by compressing the vasculo-nervous layer, sinking often in its thickness and even in the subjacent tissues. When the sebaceous matter collects merely in small quantities, the excretory ducts of the follicles of this name present a black appearance, and the matter may be readily discharged by means of pressure. When the accumulation becomes more considerable, the orifice of the follicles still remains open, and the small *tumour* which results is termed a *pimple;* but if it enlarges, and the orifice becomes obliterated, the pimple forms one of the kinds of wen known under the names of *meliceres*, *steatoma*, and *atheroma*, names which refer to a single disease, and are merely expressive of the nature and consistence of the matter which the wen contains, and accordingly as it may be compared to honey, suet, or a kind of soft pultacious substance.

In protracted diseases accompanied with marasmus, the skin appears to participate in the general decay, and presents a remarkable rugoseness, a disagreeable sallow aspect, which is very common in phthisical persons. It also, some-

times, appears to be affected with a kind of local hypertrophia, in consequence of prolonged irritation.

The solutions of continuity of the skin are re-united either immediately in consequence of the effusion of coagulating lymph, or by the formation of a new tegumentary membrane on the denuded surface. When a portion of skin has been removed, the cellular tissue becomes the seat of the cicatrization, the whole process of which may be observed to take place in the same manner as we have described in the first chapter. When the cicatrization is completed, the skin is replaced by a tissue sufficiently analogous to its own, but which differs, however, in some respects, and is always readily distinguished. In effect, this tissue is more dense, and less vascular than the original; has generally no papillæ, though its external surface, which is ordinarily smooth and polished, presents, sometimes, honeycomb-like (ganfries) inequalities. As to the colour of the cicatrices, it is more pale than that of the skin in the European; but in the negro it is at first of a white reddish colour, and gradually converges into that of the neighbouring teguments with which it is finally confounded.

When the epidermis alone has been removed, it is speedily reproduced, unless the subjacent laminæ are so much irritated as to suppurate, a circumstance which materially retards the formation of the new epidermis, and may even modify it in such a manner as to give it the appearance of a new tegument.

Inflammation of the skin assumes a variety of forms, according to the part in which it is seated; its intensity, its cause, the nature of its secretion, &c. Hitherto, physicians have paid but little attention to the study of the anatomical characters of the cutaneous phlegmasiæ; their exterior forms have almost alone been observed; and it is after these and an often hypothetical etiology, that they have classified this order of diseases. It is on this account, there-

fore, that we possess no satisfactory information with regard to their true pathological anatomy.

The *erythematous* inflammations of the skin,* that is, those which constitute erysipelas, the irruptions of scarlatina, the first stages of a burn, the action of rubefacients and of vesicatories, are characterized by a vascular injection, which affects either the superficial laminæ, or the entire thickness of the skin, and remains evident during life by its bright red and sometimes purple colour, and by the uncircumscribed swelling of the affected organ. When the inflammation is slight, the redness disappears upon pressure, and returns as soon as the cause is removed; the disease is dispersed, and the epidermis falls off in furfuraceous scales; or, if the patient dies in consequence of other accidents, there is not the least discoverable trace of phlegmasia. When, however, the disease is more intense, the dermis, (and chiefly its most superficial parts) is penetrated by a great quantity of blood, becomes swollen and bright, and exhales a yellowish serous fluid, or pus, according as the inflammatory state is more or less intense or protracted. It is this which is observed especially in the cutaneous inflammations brought on by vesicatory medicaments; the first effect of the inflammation which they occasion is the secretion of serum, which raises the epidermis; hence, phlyctænæ and blisters. The epidermis breaks spontaneously or artificially, falls off in shreds, and exposes the inflamed dermis, whose secretion now becomes purulent. In cases where the inflammation is intense or protracted, it leaves traces after the death of the individual, that is, the dermis is more or less injected, thickened and indurated in the dead body, and is sometimes penetrated, and as it were combined with the blood which fills its vessels: in certain cases, the cells of the dermis are filled with a gelatinous fluid, and its most internal ones are deprived of

* From ερυθεμα, ruber.

the fat which they contained, by the intensity of the inflammation. Finally, the subjacent cellular tissue becomes generally œdematous, and sometimes even inflamed and penetrated by a purulent fluid (phlegmonous erysipelas). The cutaneous inflammations often terminate in gangrene, especially when they have been very intense or brought on by a septic cause: in this case the surface of the affected skin presents a livid or purple colour, and is surrounded by a yellowish tint; it is now covered by phlyctænæ, and after these have broken, the denuded dermis exhibits small gangrenous spots, which invade, in the course of a few hours, a more or less considerable extent of the affected part, and even of the subjacent tissues. Scarifications of the skin, performed with the view of discharging excessive œdematous infiltrations, very readily and frequently bring on gangrene.*

We ought also to refer to the gangrenous inflammations of the skin, the disease called authrax, a circumscribed inflammation, which is owing to a peculiar contagious agent, and is characterized by the presence of a hard, reddish, homogeneous, gangrenous eschar, situated in the thickness of the skin, and having a tendency to extend by invading the adjacent tissues. The skin of the part affected is livid, œdematous, and has a number of small blisters upon its surface, which contain a kind of sanious fluid.

Furunculi are also, according to the common opinion, a cutaneous gangrenous inflammation, characterized by the presence of a whitish eschar termed the *ventriculus furunculi*, (bourbillon) which is situated in the dermis, or even in the subcutaneous cellular tissue, and results from the

* It appears, according to the observations of M. Andral, Jr., that venous congestion of the dermoid tissue is sufficient to bring on gangrene, when the skin is very slightly inflamed, or even when it exhibits not the least sign of phlegmasia, as was observed by this author in some diseases of the heart where the difficulty of the venous circulation was excessive.

mortification of a portion of skin or of the cellular tissue, which has been strangulated in consequence of the inflammation and swelling of the surrounding parts.—It seems difficult to admit the gangrenous nature and strangulation of the ventriculus furunculi; for as M. Gendrin observes, it does not present the characters of the eschars of the cellular tissue, and it occurs, moreover, when the inflammation and swelling are so slight, as to be unable to occasion the pretended strangulation to which we have just alluded. It is more probable that the ventriculus of furunculi and of authrax, results from a peculiar secretion, which is deposited into the areolæ of the dermis.

The skin is often affected with peculiar acute inflammations, which are characterized by the development of more or less numerous pustules, and are chiefly confined to the different kinds of *variola, vaccina,* and *rubeola.*

The pustules of the genuine variola occupy the thickness of the dermis, which is of a red colour around their circumference, and is sometimes infiltrated with serum: during their stage of development, they present a flattened umbilical form, and an areolar spongy disposition. If the pustules now become dry and detached, they generally leave no trace of a cicatrix, or at all events it is small and superficial, as in the distinct variety of small-pox, where the pustules are insulated and not very numerous. When the pustules, however, pass to the suppurative stage, their base is converted into a small ulcer which leaves a depressed reddish cicatrix, which is more red at first, but finally becomes more pale than the surrounding teguments: this forms the confluent variety of small-pox in which the pustules are exceedingly numerous and approach each other, and finally coalesce; the skin is swollen, often œdematous, and presents sometimes gangrenous points. Before the pustules of small-pox suppurate, they contain a limpid serous fluid, which by degrees becomes more thick and assumes a whitish appearance. This disease may be com-

municated by inoculation. When the pustules are conical or flattened, are situated merely upon the superficies of the dermis, and leave no cicatrices, they constitute the pseudo-variolic or varicellic eruptions, and the varioloid or modified small-pox of vaccinated subjects, and of those who have had the genuine variola.

Inoculation with vaccine matter by means of a lancet introduced under the epidermis, is followed by the development of a round pustule, sunk within the epidermis, projecting upon the surface of the skin, depressed in its centre, and surrounded by a red areola. This pustule contains a limpid serous fluid, disseminated through small cells which are separated by radiating and concentric septa. After a certain length of time it dries, is converted into a crust, and retains its circular and umbilical form; when it falls off it leaves a superficial and dotted cicatrix, which is more red at first, but gradually becomes whiter than the surrounding skin. When the vaccine matter has been bad, the puncture is followed by the development of a simple vesicle, destitute of an areola, having a small tubercular eminence, and disappearing without a trace of the puncture. In subjects that have been vaccinated, the vaccine inoculation frequently produces pustules, which differ merely from the true pustules by their situation upon the surface of the dermis; the fluid which they contain being proper for vaccination.

In rubeola, the vascular retiform lamina of the dermis, presents a phlogose appearance around the pustules, which are very small and sensible to the touch.

The different species of herpes all arise from chronic cutaneous inflammation. They vary in form, and most of them appear to have their seat in the superficial or epidermic laminæ of the skin. M. Gendrin is of opinion that they originate in the sebaceous follicles.—The different kinds of tinea appear also to attack at first, the superficies of the skin, and to be propagated by degrees to the thick-

ness of this membrane. It has long been known to physicians that the *tinea favosa* has its seat in the sebaceous follicles and the bulbs of the hair. The skin is susceptible of undergoing fibrous and cartilaginous transformations; of the excessive development of the retiform lamina, giving rise to certain congenital stains (nævi,) which are of a red or purple colour, and of an alteration of the pigmentum nigrum. In those persons termed Albinoes the pigment is entirely wanting, in consequence of which the skin presents a whiter appearance than naturally, with a slight shade of red, owing to the presence of blood.

SECTION 3.

Of the Mucous Membranes.

Synonyma: Glandulous membranes, internal membrane of the intestinal canal, of the nasal fossæ, &c., pituitary membrane of the nasal fossæ, villous membrane, villoso-papillary membrane, &c., in the digestive apparatus.

Definition.—Under the generic name of mucous membranes are comprehended all those parts of the tegumentary system, which being continuous with the skin, dip into the interior parts of the body and line all the cavities which communicate with the exterior world.

Division.—The internal tegumentary system consists of two non-continuous parts, the *gastro-pulmonary* and the *genito-urinary.*

Situation and arrangement.—The gastro-pulmonary mucous membrane lines the mouth, where it is continuous with the skin of the lips, and successively the pharynx, the œsophagus, the stomach and intestines at the extremity of which it is again continuous with the skin: during this course the gastro-mucous membrane sends different prolongations to the excretory ducts of the glands which communicate with the intestinal canal. In the fauces,

the gastro-pulmonary membrane sends prolongations, under the name of the pituitary membrane,* to the nasal fossæ and their sinuses, presenting an exterior communication on the margin of the nostrils where it meets the skin, penetrating superiorly into the nasal canal, lining a part of the globe of the eye and the internal surface of the eyelids, at the free margins of which it gives place to the skin: in the posterior part of the mouth it enters the Eustachian tube, lines the cavity of the tympanum and the mastoidean cells; in the inferior part of the pharynx it dips into the larynx, the trachea, the bronchia and all their ramifications.

The genito-urinary mucous membrane of the male subject, begins at the corona of the glans penis, enters the urethra, lines the internal surface of the bladder, the ureters, the infundibula, and even the calices of the kidneys. In the female it commences at the internal surface of the labia pudendi, and, after having lined the clitoris and the vulva, it sends prolongations into the urinary passages, which it lines in the same manner as in the male, invests the vagina, extending as far as the cervix uteri, is reflected upon its external surface, but is so indistinct in the cavity of this organ that its existence is dubious.†

* Also called the Schneiderian membrane, in honour of Professor Schneider, a German anatomist, who published about the middle of the seventh century. S. D. G.

† The opinion of the non existence of the mucous membrane in the cavity of the uterus, entertained by some anatomists, has no doubt arisen from the fact that this membrane, in lining the uterus, becomes exceedingly soft, delicate and vascular. At the cervix uteri it is tucked up in the form of transverse *rugæ*, which have sometimes been described as being disposed in a foliated direction, and, in the cavity of the womb, there are a few smaller rugæ, arranged longitudinally, in respect to the body of the uterus. Between these rugæ there are several follicles which secrete a mucous fluid. From the cavity of the womb, the mucous membrane extends to the fallopian tubes, invests them completely,

Conformation.—The form of the mucous membranes, like that of the whole system to which they belong, results from the conformation of the parts which they cover. Nevertheless, this form is modified by the numerous folds which are presented by this membrane in several parts of its extent. The largest of these folds form true valves, composed of two laminæ, contiguous at their adherent surface, and containing between them cellular tissue, blood-vessels, and muscular fibres, as in the velum pendulum palati and the ilio-cœcal valve. Many of these duplicatures occur on the internal surface of the small intestines, but they are much smaller than the preceding, and are known under the name of *valvulæ conniventes.* Finally, these duplicatures occur on the internal teguments in the form of simple *rugæ,* which add to the size of the organ which they cover: in the stomach they are distinguished by their volume; in the vagina, by their regularity.

Surfaces.—The mucous membrane presents two surfaces, one of which is free, the other adherent; the first presents small inequalities, formed, some by the small papillary eminences and villi, others by the small depressions which constitute the mucous and phaneric follicles.

The papillæ are small conical eminences, which are conspicuous only in some parts of the mucous membranes, and particularly on the superior surface of the tongue, on the corona of the glans penis, and the clitoris; they are formed of all the laminæ of the mucous membranes. The villi belong probably exclusively to the gastro-intestinal membrane, and are particularly conspicuous in the stomach, the duodenum, and the jejunum. They consist of small foliaceous eminences, varying in form, and being generally larger at their free extremity than at their point of insertion, and formed by the entire thickness of the membrane, on the surface of which they unite and present a velvety ap-

and projects, according to some anatomists, beyond their broad extremities so as to form their fimbriated processes. S. D. G.

pearance. These small prolongations are short and large in the stomach and duodenum; long and narrow in the jejunum and the commencement of the ilion: they are disposed in nearly parallel lines. Some anatomists are of opinion, that the free extremities of the villi are provided with small orifices, which, according to them, are the open mouths of the capillary vessels. The follicular depressions, which are observed on the free surface of the mucous membranes, consist either of simple porous orifices or of small lacunæ; but, besides these follicles, there are others, which, though unimportant in the human subject and only observable in his alimentary canal, with the aid of the microscope, are very well developed in the second stomach of ruminating animals, where they constitute the large cells and alveoli of the mucous membrane.

The adherent surface of the mucous membranes presents numerous small eminences, which are formed by their follicular depressions, and is firmly united with the sub-mucous layer of the cellular tissue, to which we alluded in the first chapter. This layer, which forms one of the tunics of the hollow organs, and which has been improperly termed the *nervous coat*, gives attachment to the fibres of their muscular tunics, adheres sometimes to the periosteum or the perichondrium, and in some instances, as in the aerial passages, to the fibrous or fibro-cartilaginous organs. In these cases, the adhesion is generally so intimate that it is often impossible to separate the mucous membranes from the subjacent parts: hence, the name of the fibro-mucous membranes. The adherent surface of the mucous membranes is in relation with a great number of vessels and nerves, and, we have already seen, that in the duplicatures which they form, the external surface is contiguous to itself, and has interposed between its two laminæ, a layer of cellular substance, and sometimes a plane of muscular fibres.

Structure.—There are not only great differences in the

organization of the external and of the internal teguments, but also in the different parts of the latter. Thus, the mucous membranes do not by any means, and in a very evident manner, present all the laminæ which enter into the composition of the skin; and besides, the number of laminæ which it is possible to distinguish in them, is not the same in the different parts of these membranes, nor are their anatomical characters everywhere alike. In regard to their organization, it is to be observed, that the mucous membranes do not present a distinct retiform body, and that we can distinguish in their composition only two layers, the *chorion* and the *epidermis*. Under the second point of view we may observe, that the epidermic layer, which is here known under the name of *epithelium*, is only appreciable in certain parts of the mucous membranes, viz. from the mouth to the cardaic orifice of the stomach, from the vulva to the cervix uteri, and generally, to a certain extent, in those parts where the mucous membranes are continuous with the skin. As to the differences which exist between the two laminæ composing the internal teguments, and the layers which correspond to those of the skin, the following description will suffice to give an idea.

The chorion, or mucous dermis, alone constitutes the mucous membranes of the mastoidean and frontal sinuses, the conjunctiva of the eye, of all the excretory ducts, of the stomach and intestinal canal, and of the whole urinary apparatus, except in the neighbourhood of the external orifice of the urethra. The chorion is presented under the appearance of a soft, spongy substance, apparently destitute of texture, except in the neighbourhood of the skin; the layer which it forms is generally much thinner and denser in proportion as it recedes from the skin, being remarkably tenuous and delicate in the prolongations which line the excretory ducts. The mucous dermis is extremely vascular, and its vascularity is in direct ratio with the number of the different follicles, the

papillæ and villi which it presents in the different organs. As to the nerves of this layer, they can only be traced to certain parts of its extent, as to the papillæ, the pituitary membrane, &c. The papillæ of the mucous dermis are formed of the capillary vessels and nerves which are upon its surface, and are defended by cellular tissue: the disposition of the capillary veins of these small eminences is such as to render them erectile, a property which is very conspicuous in the papillæ of the tongue during degustation.* The villi are composed of lymphatic and sanguineous capillaries, which project upon the free surface of the mucous dermis, and are accompanied and protected, like the papillæ, by cellular substance.

The epidermis of the mucous membranes is, as we have already said, found only in certain parts of the internal tegumentary system. Wherever it does not exist, and particularly upon the villi of the intestines, there is a layer of diffluent substance which covers the chorion, and appears to fulfil the office of the epidermis, which itself is perhaps nothing more than this substance in a state of desiccation. In other respects, the epidermis, which is more thick where it covers the papillæ, and especially upon the tongue, than anywhere else, becomes gradually more and more thin and delicate as it recedes from the skin.

The *mucous follicles* or *glandulæ muciperæ* are formed, like those of the skin, by the depression of the internal tegument: they consist of very small cysts with a narrow neck, and open upon the free surface of the mucous membrane by a funnel-like orifice. They are generally found in every part of the mucous system; but on account of their volume they can not be every where readily perceived: they occur either separately or in clusters, and

* Between the dermis and the epidermis of the lingual papillæ, there is a kind of diffluent substance, which is probably analogous to the rete mucosum of Malpighi. It is destitute of the pigmentum nigrum.

where this is the case, they open separately upon the surface of the mucous membrane, or they terminate in one or more small cavities, which are commonly called *lacunæ*, and which perform the office of excretory ducts: the amygdalæ are nothing but a mere cluster of follicles, and the same obtains, with regard to the glands of Cowper, the prostate, and the caruncula lacrymalis. In the fossa navicularis of the urethra, the base of the tongue, &c., they are smaller and less numerous, and the *lacunæ* upon which they border are sufficiently well developed. The mucous follicles receive numerous blood-vessels and nerves, and wherever the epidermis exists, it penetrates into their excretory ducts.

Characters, physical and chemical properties.—The colour of the mucous membranes varies from a beautiful red to a faint rose or grayish. The former generally occurs in the neighbourhood of the skin, particularly on the lips, the tongue, the fauces, the internal surface of the eye-lids, the glans penis, the vulva, &c.; the latter is found in the greatest part of the teguments of the alimentary canal of the genito-urinary apparatus, &c. The mucous membranes which are in relation with the bile, commonly receive a yellowish tint, which is more conspicuous after death than during life, on account of the greater activity of the imbibition of the fluids in the dead body. The thickness and density of the mucous membranes are extremely variable; they are generally at their *maximum* in the neighbourhood of the skin, (if we except the conjunctiva, which is exceedingly delicate,) and, in proportion as they recede from this, they become gradually thinner: the mucous membranes of the minute ramifications of the bronchia, of most of the excretory ducts of the glands, and of the frontal and maxillary sinuses, are at the *minimum* of the two characters to which we have just alluded. In general, the internal teguments are of a soft, spongy consistence, have but little tenacity, but a great degree of *hygrometricity*.

They are essentially gelatinous, and when exposed to putrefaction, they yield readily to its action. By the concentrated sulphuric acid, they may be converted into a soft, pulpy mass; while the nitric acid imparts to them a yellowish orange colour before it dissolves them, especially to those of the lips, of the pharynx and the œsophagus. This is an important character to be known, because it constitutes one of the signs of poisoning by this fluid, though it produces the same effects in the other organic solids of the body.

Vital properties.—The mucous membranes are slightly contractile; and although they are generally sensible, this property is obscure in the greatest part of their extent; it is more remarkable in the neighbourhood of the external teguments, particularly in the mucous membranes of the mouth and nasal fossæ, which are supplied with the nerves of taste and of smell, and in the tegumentary membranes of the glans penis and of the vulva.

Differences according to age.—In the fœtus, the mucous membranes are extremely thin and soft, and their papillæ are indistinct; their adhesion to the subjacent parts is readily broken, and their colour is rather violaceous than red. The mucous membrane of the intestinal canal, at the same time, contains a brownish matter, which resembles the juice of the poppy, and is hence called *meconium.*

After birth, the internal teguments retain for a long time, their softness and delicacy. They are generally of a faint reddish colour, which is more distinct in infancy and youth than at any other period. In adult age, they gradually lose their reddish appearance and become grayish: in old age, they become more dense, and lose their velvety character.

Functions.—The mucous membranes are organs of absorption, a function which they enjoy in a very high degree, in consequence of the softness and delicacy of the epidermis, and on account of the absence of this lamina in

the greater part of their extent. In the digestive canal, this function is rendered extremely vigorous by the presence of the small vascular papillæ.

The mucous membranes are also organs of serous and mucous secretions: the latter of which belongs chiefly to the mucous follicles. The mucous fluids vary in the different parts of the internal tegument, though they every where contain animal mucus, which forms their basis.*

Some of the mucous membranes are the seat of particular sensorial impressions, by virtue of the nerves which they receive; thus, the sensation of hunger is referred to the mucous membrane of the stomach, that of taste to the mucous membrane of the mouth, and especially to the papillæ on the surface of the tongue, and that of smell to the mucous membrances of the nasal fossæ. There is also a very remarkable connexion between the mucous membranes and the skin, the circulatory centre, the nervous system, &c.

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The mucous membranes participate in the congenital or acquired mal-conformations, as well as in the displacements of the organs which they cover: they are also subject to peculiar deformities, as in cases of hernia.

When a mucous canal ceases to be traversed by the fluids to which it gives passage, it undergoes a more or less considerable contraction: on the contrary, however, when the fluids are more abundant than usual, the mucous membrane becomes much dilated, and recovers but slowly its primary dimensions after the cause of its distention has ceased to act.

Inflammation of the mucous membranes is a very frequent and often a very troublesome disease. It is generally characterized by a coloration which varies from a rose

* It is impossible to give a correct analysis of these fluids, on account of their being more or less mixed with the other secretions, such as the lacrymal fluid, the saliva, the bile, the pancreatic fluid and the urine.

to a deep brown, and is presented either under an arborescent form, or under that of small red points disseminated over a pale or reddish base, (as when the villi alone are inflamed,) or again under that of regular uniform spots, which are most frequently of a red colour, sometimes violaceous or livid, and sometimes again argillaceous or brownish.* Besides its change of colour, the mucous membrane augments in thickness at the same time that it loses its resistance, becomes more soft, and is easily detached from the subjacent tissues. Its secretion, which is more active at the beginning of the inflammatory stage, furnishes a kind of viscid fluid, which is more or less puriform, but often only more abundant or serous than natural; when, however, the inflammation has attained its height of intensity, the mucous secretion is completely suspended until it begins to decline: the secretion now becomes often puriform, and even purulent, without there being any ulceration of the part affected; at other times, however, the inflamed mucous membranes secrete a substance which is deposited and inspissated upon their free surface, under the form of false membranes.—The presence of similar productions in the larynx characterizes the species of laryngitis known under the name of *croup*. Pseudo-membranes are also formed in certain cases of angina pharyngea and trachialis, in some of the phlegmasiæ of the mucous membranes of the bronchia and intestinal canal, and sometimes, though extremely seldom, in the other mucous membranes. These productions are susceptible of becoming organized like those of the serous membranes, yet this is of rare occurrence, because they are ordinarily thrown off by the efforts of vomiting, by stool, &c., or because the subject succumbs in the incipient stage of the organization; at other times, the inflammation diminishes, and the internal tegument again

* The arborescent inflammatory coloration is the only one which yields to washing and maceration; all the others do not undergo the least diminution of intensity.

secretes a fluid, which raises the false membrane and detaches it completely; or the secretion not taking place, the morbid production gradually diminishes, becomes semi-transparent, and finally entirely disappears. The acute inflammations of the mucous membranes sometimes terminate in ulceration: in this case their edges are somewhat jutting, extremely red, and covered, like their base, with a mucous puriform substance. These phlegmasiæ also sometimes terminate in gangrene, either by reason of their violence, or because of their essentially phagedenic character, as is the case in the anginose gangrenous epidemics; the development of small vesicles upon the affected part often indicates this termination. The eschars of the mucous membranes vary from a grayish to a blackish-brown colour, and commonly present the appearance of a putrid deliquescence.

In many subjects who die with croup there are symptoms of mucous fever, an inflammation of the cryptæ of the internal gastro-intestinal tegument, which produces genuine pustules, of a grayish or whitish colour, and filled with a mucoso-purulent fluid; in the centre of these pustules we observe a small depression or black point, which indicates the orifice of the crypta. This affection has been chiefly described by Rœderer and Valger. M. Bretonneau, of Tours, however, has paid much attention to the pustulous inflammation of the follicles of the mucous membrane of the intestines, and has given it the name of *dothinenteritis*,—a disease which readily assumes a chronic character, and often terminates in ulceration of the affected cryptæ. In small-pox the mucous membranes are sometimes affected with pustulous inflammations: in these cases, the pustules, ordinarily superficial, though sometimes situated in the thickness of the chorion, are not constantly depressed, nor do they appear to have the areolar disposition of those of the external tegument.

The chronic phlegmasiæ of the mucous membranes are

generally characterized by a bright red, livid or copper-colour, and by a thickening and hardening of the affected parts, whose tissue is of a more homogeneous nature than in the normal state.—The growths, which are sometimes observed on the surface of the mucous membranes, result from a morbid development of their capillaries, occasioned by a protracted irritation or chronic inflammation. The ulcerations, which are produced by chronic inflammation, are characterized by hard, elevated, jaggy edges, while the base of the ulcer is rugose, and of a red, livid or copper-colour: this morbid state is generally accompanied by the secretion of puriform or purulent matter, even where there is no ulceration. Polypi of the mucous membranes and the erectile productions, which are sometimes accidentally developed in their thickness, as well as the cartilaginous and osseous metamorphoses, may also be referred to protracted irritation or chronic inflammation. The mucous membranes are often the seat of sanguineous congestions, which may be either active or passive, accordingly as they are occasioned by the irritation of their tissue, or by an obstruction in the circulation.

In these cases the thickness, density, and consistence of the membrane are in no wise altered, nor is there any morbid secretion upon its surface. These congestions may bring on hemorrhage and even inflammation. The mucous membranes are sometimes, though rarely, the seat of pilous and corneous productions; when these are exposed for a certain time to the atmosphere they assume the characters of the external teguments. The membranes which line fistulous openings, certain cysts, and most of the purulent abscesses, may be referred to the order of mucous membranes.

SECTION 4.

Of the Appendages of the Tegumentary System.

The appendages of the tegumentary system are the solid parts which are produced by the bulbous or phaneric follicles, and project upon the free surface of the teguments. These parts are:—the hairs and the nails for the external tegument, and the teeth for the internal.—Before we enter upon the particular history of each of these products, we shall endeavour to give a general idea of the generative part—*the bulb.*

The bulb is a small vesicle, which is situated in the thickness of the dermis, opens upon its free surface, and is continuous by the margins of its orifice with the tegumentary membrane, of which it is really a mere depression: in fact, the small organ of which we are speaking is composed, 1st, of a lamina which is analogous to the dermis, and which, being in relation with the subcutaneous cellular tissue, gives passage to blood-vessels and nerves which ramify principally upon its concave surface; 2d, of a pulpy substance which is formed, as it were, of the termination of the blood vessels and nerves of the chorion, and represents the rete mucosum of Malpighi; 3d, and lastly, of the dead inorganic product, which is analogous in this respect, and sometimes also in its chemical composition, to the epidermis.

ARTICLE 1.

Of the Hairs.

Definition.—The hairs are the filamentous inorganic parts, which project upon the free surface of the external tegument, and are of variable length, fineness and delicacy.

Division and situation.—The hair is distinguished by different names according to the part where it is situated, as *capillus*, on the scalp; *supercilium*, on the eye-brows; *cilium*, on the eye-lids; *circrinus*, on the temples; *barba*, on the chin, and *mystax*, on the upper lip. The generic name of hair, moreover, is applicable to all the pilous productions which occur upon the surface of the trunk, and the extremities. There are no hairs in the palm of the hand and the sole of the foot; and they are extremely *thin* and delicate in some parts of the face, the internal parts of the extremities, and on the back: they generally occur in considerable abundance on the sternal parts of the thorax, and the external parts of the extremities, particularly in the male.

Form.—The generative part, or pilous bulb, represents a small ovoid vase, which is open on the free surface of the teguments. The hair, properly so called, is of a conical form, being more delicate at its free than at its bulbous extremity. It is either straight, twisted, or curled.

Structure.—The bulb of the hair is really nothing but a small oblique depression of the skin, and consists of the same number of laminæ. The pigment itself exists in the part which represents the rete mucosum. The greater part of the bulb is filled by a cone of pulpy substance; and upon this papilliform body is implanted the inorganic part, or the hair properly so called. At its adherent part, the pilous follicle has capillary vessels and nerves which stimulate its small roots.

The hair itself embraces, by its hollow and diffluent base, the pulpous cone of the bulb; and the surrounding epidermis, after having invested the orifice of the bulb, is reflected upon the base, and is confounded with the hair.*—The

* This double mode of union of the hairs with the skin, renders the adhesion of these two organs so intimate, that it can not be broken without a certain degree of difficulty and of pain. All such efforts as have a ten-

hair is a white epidermic sheath, containing a colouring matter which is disposed in numerous filaments, between which there is a liquid substance for the purpose of connecting them with each other, and with the sheath. This interior coloured part represents the rete mucosum of the skin, and upon it depends the colour of the hair.—Neither blood vessels nor nerves can be traced into the substance of the hair itself, the bulb being the only part which receives them.

Characters, physical and chemical properties.—The colour of the hair varies in different individuals from white to jet black, passing through a number of intermediate shades of pale yellow, reddish, auburn, &c.: it is never of a blue, green, or yellow colour, &c. In the Albinoes the hairs are of a white appearance. Their colour is generally the same in the different parts of the surface of the body; yet there are many exceptions to this rule. The thickness or diameter of the hairs is very different in the different parts of the same individual; thus, the hairs of the pubės are the thickest; and in regular succession those of the axillæ, the head, the eye-brows, the eye-lids, the beard, &c. The medium of this diameter is about the six hundredth part of an inch. Fair hair is generally the most fine and delicate; black, the most rough. The hairs greatly resist such causes as have a tendency to rupture them transversely, but they are easily divided in a longitudinal direction. They are dry and solid externally, fluid at their adherent extremity, and soft within: they evidently absorb humidity, and enlarge.*

The hairs resist for a great number of years the action of putrefaction. By long continued boiling in Papin's digester, they are gradually dissolved, and are finally converted

dency to detach the epidermis from the subjacent laminæ, have the same effect with respect to the hair of the scalp.

* It is to a knowledge of this fact that we are indebted to the hygrometer of M. De Chaussier.

into mucus, after having disengaged a quantity of hydro-sulphuric acid gas. According to the analyses of Vauquelin, black hair contains a large proportion of an animal substance, similar in all respects to mucus, a white inspissated oil, a small quantity of thick oil of a greenish black colour, traces of the oxides of manganese and iron, of silica, sulphur, phosphate and carbonate of lime, and sulphate of iron. According to this chemist, the colour of the hair depends upon the presence of the greenish oil, and the sulphate of iron. This oily matter is either of a greenish black colour, red, yellow, or nearly colourless, according as the hair is black, red, yellow, or white.

Vital properties.—The bulbs of the hair, and particularly the pulpy portions, are the only parts which enjoy any evident sensibility; the hair itself being completely destitute of vitality. The motions which are sometimes observed in the hairs depend upon the contractions of the cutaneous tissue.

Differences in the different races of men.—The varieties of colour which we have just pointed out belong almost exclusively to the individuals of the Caucasian race; and amongst them we may observe that those who inhabit the northern countries, have generally a fairer and lighter pilous system, than those of the southern regions. In all the other races the hair is black. In the Caucasian and Malay, the hair is generally long, fine, *thick*, and often curled; it is fine and *thin* in the American, short and coarse in the Mongolian, crisped and woolly in the Ethiopian.

Differences according to age and sex.—At about half the term of pregnancy, the skin of the fœtus is covered with an external soft and delicate down, which falls off sometime after birth, and of which traces may be found in the liquor amnii. The hair of the head, the eye-lids, and eye-brows, appear in the latter months of gestation, and are the first amongst the permanent pilous parts which are developed. The other hairs do not appear until after the

age of puberty. In infancy the hair is generally more fine and soft, and of a lighter colour than in adult age. In the decline of life, (and sometimes before) the hairs become white and fall off: in old age they are white and thin. In the female, we generally observe neither beard,* nor whiskers, and the hair upon the chest and the external parts of the extremities are very thin and delicate.

Functions.—The pilous bulb secretes the substance which forms the hair.—The hair is an organ of protection of the skin, and is subservient to the tactile sensations by the facility with which its generative pulp receives the impressions from such bodies as touch the hair.

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When the hairs are plucked out, they are always reproduced, provided the bulb, has not been destroyed: the same thing takes place in the diseases of the bulb which occasion the falling off of the hair. The bulb is sometimes completely altered by a protracted inflammation, its pilous secretion ceases, and the hairs lose their colouring matter. This phenomenon, as we have already said, is a natural consequence of the progress of age, in which case the change of colour of the hair takes place in regular progression; but often, and chiefly, in consequence of moral impressions, such as fear and grief, they become suddenly hoary before the ordinary period. In these cases they sometimes, though seldom, recover their primary colour. We are ignorant in the present state of our knowledge, of the changes which supervene in the follicles of the hairs after their removal or discoloration. In the disease called *plica,*† the hairs of the scalp acquire an extraordinary

* There are some individuals of the female sex, however, who have a *sort* of beard, especially on the upper lip, which comes on either about the period of puberty, or after the cessation of the menses.

† This disease, generally termed *plica polonica,* is almost peculiar to the inhabitants of Poland, Lithuania, and Tartary.—S. D. G.

length, and become entangled in a very intricate manner: some have even asserted that they become vascular and sensible; but perhaps there is nothing real in this opinion, which at least has been exaggerated. Béclard has endeavoured to account for the facts upon which this opinion rests, (the hemorrhage and pain which accompany their cutting,) by supposing, that in consequence of the irritation which the bulb experiences in the disease to which we have alluded, the pulp which secretes and embraces the hair tumefies, becomes raised above the level of the teguments, and is then entangled by the instrument with which the affected part is shaved.

Hairs are sometimes accidentally developed in consequence of inflammations of the skin, and even in those parts where they do not ordinarily occur. Numerous cases have been related in which hairs are said to have been found in the organs which are lined by mucous membranes; but in most of them they appeared to have been introduced. They have also been sometimes found in certain cutaneous cysts, and in the ovarium, in cases of extra-uterine pregnancy: in these instances the hair is extremely delicate, and of a whitish appearance. The hairs, which some authors, such as Bonet, and Amatus Lusitanus, are said to have found upon the heart, were probably nothing but mere pseudo-membranous filaments.

ARTICLE 2.

Of the Nails.

Definition.—The nails are the hard, transparent lamellæ, which cover the dorsal parts of the last phalanges of the fingers and the toes.

Form and disposition.—The nails are oblong, and curved in such a manner as to be moulded upon the parts which they cover. They are divided into a *root, body,*

and *free extremity.* The root is posteriorly and is placed within a duplicature of the skin; it is the most soft and delicate part of the nail. The body is continuous with the root, which it exceeds in thickness; it presents posteriorly a white semi-lunar part with the convexity before, which is called the *crescent;* in the rest of its exent, the body of the nail is of a faint red colour, and its transparency is such as to permit the colour of the subjacent cutaneous tissue to be seen. The anterior or free extremity, which is more thick than the preceding portion, projects more or less beyond the dorsal part of the finger. When nothing prevents its growth, the free extremity becomes long and crooked and acquires an increase of thickness. The nails present two surfaces, one of which is convex, the other concave; both are adherent at the posterior part, and free at their anterior extremity; at the middle part, the concave surface is adherent, but the convex surface is free. The nails adhere to the subjacent cutaneous laminæ, throughout the whole extent of their circumference, by means of the surrounding epidermis which serves to unite them, without, however, its being confounded with them; and, besides, their root, which is lodged within a kind of furrow of the skin, is there intimately connected with it. Under the root of the nail, the dermis is of a whitish appearance, from which results the semi-lunar spot called the crescent; under the middle part, on the contrary, the dermis is very vascular, and furnished with small papillæ.

Structure.—The nails have been regarded by some anatomists, particularly by Bichat and J. F. Meckel, as being formed of a substratum of epidermic laminæ, whose extent diminishes successively from behind forwards, in such a manner, that the most exterior layer forms the length of the nail, and the most internal its shortest part. This, in fact, appears to be the only true explanation of the differences in the thickness of the nails in the different parts of their extent. According to others, however, such

as Blancardi and M. de Blainville, the nails are pilous productions, which are agglutinated together, and are derived from bulbs similar to those which we have described in the preceding article. Indeed, the longitudinal striæ which are observed upon the two surfaces of the nails, would appear to indicate an analogy between them and certain corneous productions, which very evidently result from the agglutination of a great number of hairs.* Notwithstanding, however, the plausibility of these opinions, we are unable to decide whether the nails are merely a thick corneous epidermic layer, or whether they are secreted by pilous bulbs.

Characters, physical and chemical properties.—The nails are whitish,† semi-transparent, hard, flexible and elastic, and, like the epidermis, they are principally composed of concrete albumen.

Vital properties.—The nails are destitute of vitality.‡

Differences according to age.—The nails are brought into existence about the fifth month of fœtal life. Their thickness and consistency, at first inconsiderable, gradually increase, so that in old age they become very hard and firm. At birth, the nails do not always reach the extremity of the finger, and seldom jut beyond it.

Functions.—In man, the nails serve merely to defend the free extremities of the fingers: the habit of paring them, common to most people, renders them unfit for laceration.

* According to some anatomists, these striæ are owing to the linear disposition of the papillæ of the dermis.

† In the coloured races, the pigmentum nigrum is situated in the subjacent parts, and the blackish appearance of the nails is entirely owing to their transparency.

‡ The fact that so much pain is felt when the nails grow into the flesh, and that the operation of tearing them out is so extremely painful, is no doubt owing to the lesion of the surrounding parts.—S. D. G.

Pathological Anatomy.

When a nail has been torn out, or has been detached in consequence of a disease of the subjacent dermis, it is replaced by another, which bears more or less resemblance to the first, accordingly as the generative part is healthy or altered; in the latter case, it may even happen that there will be no reproduction at all. The nails are often subject to excrescences, or a preternatural thickening. In scrofulous subjects, or those who are affected with chronic diseases, such as phthisis, &c., they often become more brittle, thin and convex, than in the healthy state. When the nails grow into the surrounding tissues, it often gives rise to a very painful affection, which may be attended even with inflammation of the skin which is in contact with the sharp edge of the nail. This affection is almost exclusively confined to the great toe, and is occasioned by the wearing of tight shoes.

ARTICLE 3.

Of the Teeth.

Definition.—The teeth are the small, hard, calcareous organs which are fixed in the alveoli of the superior and inferior maxillæ, and are produced by the follicles which are dependant on the mucous membrane of the mouth.

Division.—Each tooth consists of a body and a root, or that part which is fixed in the socket. The boundary between these two is called the neck of the tooth.

Texture.—The teeth present two well marked and distinct parts, one of which is organic, the other inorganic.

The organic part consists: 1st, of a membrane which covers the root of the tooth and is continuous with the mucous membrane of the gums; 2d, of a neuroso-vascular pulpy substance which represents the form of the tooth, and is

surrounded by it on all sides, except in one or two points where it communicates with the preceding membrane by blood-vessels and nerves.

The inorganic part is exactly moulded upon the pulp, and is composed of two substances; one of which constitutes almost the entire tooth, and is called the *osseous* or *ivory substance;* it is disposed in laminæ and has neither cellular tissue, blood-vessels nor nerves, nor the areolar texture of the bones. The other substance is termed the *enamel*, and forms a layer which covers the preceding; it is of a white, milky, brilliant, semi-transparent appearance, more hard than the ivory part of the tooth, upon which it is exactly moulded, and becomes thinner as it approaches the neck of the tooth. The enamel has no trace of organization; it is disposed in undulating fibres, which are united with each other in a very exact manner, and are directed obliquely in respect to the axis of the tooth.

We see, then, that on account of their organization, the teeth could not have been included in the osseous system. Besides this distinctive character, and that which is drawn from the peculiar situation of the body of the teeth, we shall readily distinguish, in the remainder of this section, all the other differences which exist between the dental apparatus and the passive organs of locomotion. The dental apparatus is naturally placed upon the same line with the hairs, since it consists, like them, of a follicular part, a generative pulp, and an exterior dead part; their chemical composition being the only difference which exists between these two productions. Comparative anatomy throws but little light upon this subject, except by showing that the beaks of birds are analogous to the teeth of mamiferous animals.

Characters, physical and chemical properties.—The teeth are of a white, very slightly yellowish appearance, especially in their alveolar part: the crown is more or less brilliant, on account of the enamel which covers it. The

hardness of the teeth exceeds that of the hardest and most solid bone in the body, (the petrous portion of the temporal bone,) a property which they owe to their containing a greater quantity of calcareous matter.—According to the analysis of M. Berzelius, the osseous substance of the teeth is composed of phosphate of lime, 51.04, fluate of lime 2.00, carbonate of lime, 11.30, phosphate of magnesia, 1.16, soda, 1.20, and a trace of the hydro-chlorate of soda, and, according to Mr. Pepis, of a small proportion of gelatine. According to the first named chemist, the enamel consists of the same salts as the osseous part, but in different proportions: the phosphate of lime, amongst others, being much more abundant in the latter than in the enamel, which, according to Hatchett, Fourcroy and Vauquelin, is composed of the phosphate of lime, in combination with a very small quantity of gelatine.

Development, and differences according to age.—The changes which the dental apparatus experiences during the course of life are very remarkable and curious. Under this point of view, therefore, we may divide the teeth into two classes, the *temporary* and the *permanent:* the first, which have also been called the *milk* teeth, are twenty in number, are shed between the age of seven and fourteen, and are supplied by the permanent teeth. The temporary teeth are: eight incisores, four canini, and eight molares, to which are added, between the fourth and sixth year, four other molares, which do not fall out, like the preceding, and may be considered as permanent teeth. At the age indicated above, the twenty milk teeth are shed and are succeeded by an equal number of corresponding permanent teeth. The number of these organs, which is then twenty-four, (counting the four molares which remained,) afterwards amounts to thirty-two by the development of eight other large molares; four of which do not appear until between the age of eighteen and thirty, and are hence called *dentes sapientiæ.*

The dental follicles begin to be apparent about the tenth week of uterine life, but they do not appear all at the same time. They consist at first of small, round, shut sacs, lodged in the alveoli and composed of two layers, an external and an internal; the former of which is thick and intimately adherent to the gums; the other, very vascular and delicate, is a kind of net-work which contains at first a reddish fluid, that is gradually changed to a pale yellow. About the fourth month, the bottom of this small sac contains the generative pulp, which in a short time assumes the form of the future tooth. About half the term of utero-gestation, this pulpy nucleus is covered by small laminæ of ivory substance, which are soon after succeeded by others, secreted in like manner upon the surface of the pulp. So long as this pulp is covered with earthy matter only in a small proportion of its extent, it is easily to be conceived, by the facility with which it can be separated, that their bond of union is merely inorganic, and is completely destroyed at a subsequent period, though they can not be possibly separated, because the ivory substance embraces every part of the original nucleus. The part of the nucleus which corresponds to the triturating surface of the tooth, is the first that is encrusted with the ivory substance, so that its laminæ are more numerous here than in any other part: the roots are formed after all the other parts of the teeth, of which they are mere prolongations, are fully developed. The enamel of the teeth is secreted and deposited upon the surface of the crown by the internal lamina of the sac, and is easily separated in the fœtus from the ivory substance. About six or seven months after birth, the milk teeth pierce the sac which contains them, and finally the mucous membrane of the gums, with which the margins of the orifice of the sac or follicle become in a short time confounded: it is at this period that the root is developed. The different kinds of teeth are by no means formed simultaneously, nor do they appear ex-

teriorly at the same time. According to J. F. Meckel, the following general rules may be established in respect to the development and appearance of the teeth: "1st, the different stages are regulated by the same laws, so that the follicle of the tooth, whose germ appears first, is also that which is first developed, ossified and pierced; 2d, the homonymous teeth of the same jaw generally correspond; 3d, the inferior teeth are developed before the superior, and the anterior before the posterior; 4th, the gradual development of the human teeth corresponds to the permanent forms which are found in the scale of mammiferous animals."

The follicles of the permanent teeth begin to appear successively after the eighth month of fœtal life, and are at first situated in the same alveoli as those of the temporary teeth, upon which they are then placed, and are united with them by their external lamina. These follicles are soon after removed from the milk teeth, are placed at their posterior part, and are subsequently observed to be lodged within particular alveolar cavities, which result from the slight depressions at the posterior paries of the primary cells: these depressions are converted into the true alveoli, by the development of a partition between the follicles of which we are speaking, and the parts which are occupied by the milk teeth.—The milk teeth are shed in consequence of the destruction of the vessels and nerves which connect them to the jaw; a destruction which is produced by the permanent teeth, which, during the progress of their development, compress these bonds of union, and destroy in regular succession all the adhesions of the temporary teeth.

The pulp of the teeth, whether permanent or temporary, is much larger in proportion as it is examined near the period of dentition; subsequently, its vitality gradually diminishes, and is finally completely destroyed: the shedding of the teeth in advanced age, is a more or less immediate consequence of this complete atrophy of their living part. On the other hand, the continual friction of the

teeth destroys by degrees their enamel, and exposes the ivory substance. Under these circumstances it sometimes happens that the osseous part itself is worn away to the dental pulp, which, in this case, secretes a new osseous substance, which is more soft than the first, and serves the purpose of filling up the cavity of the tooth.

Function.—The incisores and canini serve to seize and to rend, the molares to triturate the food; neither of them can, however, exclusively perform one of these functions.

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The form of the teeth is often very variable, and far from being in relation with the normal type: the eminences which surmount the crown may be more numerous and projecting than ordinary; and the roots themselves may present the same kinds of anomaly, or their distribution may be unnatural,* so much so, that the fangs of two contiguous teeth may become united. The number of teeth is often less, and sometimes, though rarely, greater than that which we have indicated; in some instances, there is even a double row of these organs. In general, the supernumerary teeth are more common to the superior than to the inferior jaw. In some instances there is a third dentition a very long time after the second: the teeth are also sometimes transposed; for example, a molar tooth may occupy the place of a canine, &c. The development of the teeth often takes place in a preternatural order; and we not unfrequently observe the persistence of one or more of the milk teeth, after the corresponding permanent teeth have been already developed, and issued from their sockets. When a tooth has been fractured, it does not become con-

* In the anatomical museum of the celebrated Albinus, is an instance of the body of a molar tooth growing into the antrum highmorianum, the direction of the roots being reversed. Mayo's Outl. of Physiology, p. 125.—S. D. G.

solidated, if it is the crown that has been affected; if the root, however, be injured, its proper membranous envelope secretes an osseous substance which re-unites the fragments.

Inflammation of the dental pulp is by no means of rare occurrence, and occasions the most severe pain. It sometimes terminates in suppuration or gangrene, and very often in caries of the affected tooth: this last disease attacks particularly the teeth which have been deprived of their enamel, and more frequently the molar teeth than any other. The diseases of the gums and the jaws may also influence, in a very considerable degree, the health of the teeth.

There are sometimes adventitious dental productions, especially in certain ovarian cysts.

Bibliography of the Tegumentary System.

The works already quoted.

Hebréard. Mémoire sur l'analogie qui existe entre les Systèmes muqueux et dermoïde; Mémoires de la Société médicale d'Emulation, vol. VIII, p. 153.

Bonn. De continuationibus membranorum. 1763.

On the skin in particular.

Malpighi. De exter. tact. organ. in Épist. Londres, 1686, p. 21—33.

Gaultier. Recherches sur l'organisation de la Peau de l'homme, et sur les causes de sa coloration. Paris, 1809.

——— Recherches sur l'Organe cutané. Paris, 1811.

Dutrochet. Observations sur la structure de la Peau, dans le Journal complém., vol. V.

Meckel. De la nature de l'Epiderme et du Réseau qu'on appelle Malpighien; dans les Mémoires de l'Académie de Berlin. 1753.

Les Œuvres d'*Albinus* renferment plusieurs travaux sur

l'anatomie des diverses couches cutanées, sur les causes de leur coloration, etc.

Ch. Th. Reus. De glandulis sebaceis dissert., etc. Tubingæ, 1807.

Hintze. De papillis cutis tactui inservientibus. Leyde, 1747.

Meckel. Nouvelles observations sur l'epiderme, dans les Mémoires de Berlin, ann. 1757.

Ducrotay de Blainville. Principes d'anatomie comparée, tom. I. Paris, 1822.

Gendrin. Histoire anatomique des inflammations, t. I. Paris, 1826.

Bateman. Abrégé pratique des Maladies de la Peau, traduit de l'anglais par S. Bertrand, in-8vo. Paris, 1820.

Alibert. Description des maladies de la Peau, etc., gr. in-fol. Paris, 1806.

——— Précis théorique et pratique sur les maladies de la Peau, tom. I et II. in-8vo. Paris, 1822.

P. Rayer. Traité théorique et pratique des maladies de la Peau, fondé sur de nouvelles recherches d'anatomie et de physiologie, tom. I. in-8vo., avec atlas *idem.* Paris, 1826.

On the Mucous Membrane.

Peyer. De Glandulis intestinalium. Amstel., 1681.

Brunner. De glandulis duodeni. Francofurt., 1715.

Helvétiús. Mém. de l'Académie royale des Sciences. Paris, 1721.

Liebernkuhn. De fabr. et act. villos. intestin. hom., in-4to. Lugd. Bat., 1744.

H. Buerger. Examin microsc. villos. intestin. cum icon., in-8vo. Halæ, 1819.

Leuret et Lassaigne. Recherches physiologiques et chimiques pour servir à l'histoire de la digestion, in-8vo. Paris, 1826.

Billard. De la Membrane muqueuse gastro-intestinale

dans l'état sain et dans l'état inflammatoire, etc., in-8vo. Paris, 1825.

Gendrin. Ouvr. cité, tom. I.

On the Appendages of the Tegumentary System.

1. The Hair.

P. Chirac. Letter à M. Regis sur la structure des Cheveux. Montpellier, 1688.

Malpighi. De Pilis observationes, in op. posth.

Daverney. Œuvres anatomiques. Paris, 1768.

C. As. Rudolphi. Diss. de Pilorum structurâ. Grispswald, 1806.

Gaultier. Ouvr. cité.

Heusinger. Remarques sur la forme des Poils, *dans* Journal complémentaire du Dictionn. des Sciences médicales, tom. XIV; et sur la régénération des poils, *idem, idem,* p. 339.

Plenck. De morbis capillorum, in doctr. de morb. cut.

Meckel. Mémoire sur les Poils et les Dents qui se dévéloppent accidentellement dans le corps; *in* Journ. complémentaire du Dictionn. des Sciences médicales, tom. IV, p. 122—217.

2. The Nails.

B. S. Albinus. In Annot. acad. Lib. II, cap. XIV, de ungue humano, et cap. XV, de naturâ unguis.

Ludwig. De ortu et structurâ unguium. Lips. 1748.

Haase. De nutritione unguium. Lips., 1774.

Plenck. De morbis unguium; *in* op. cit.

3. The Teeth.

A. Serres. Essai sur l'anatomie et la physiologie des Dents, ou nouvelle théorie de la Dentition. Paris, 1817.

Geoffroy-St.-Hilaire. Système dentaire des Mammifères et des Oiseaux, embrassant sous de nouveaux rapports les principaux faits de l'organisation dentaire chez l'homme. Paris, 1824.

J. Fr. Meckel. Essai sur le développement des Dents chez l'homme; dans Journal complémentaire du Dict. des Sciences médicales, tom. I, p. 365.

F. Cuvier. Des Dents des Mammifères, ets. Paris, 1822 à 1825. Onze livraisons in-8vo., avec figures.

J. Fox. Histoire naturelle des maladies des Dents de l'espèce humaine, traduit de l'anglais par Lemaire. Paris, 1821.

J. Lemaire. Traité sur les Dents. Paris, 1822.

CHAPTER IX.

OF THE GLANDULAR SYSTEM.

Definition.—The glandular system consists of a certain number of organs, furnished with numerous excretory ducts which unite in one common trunk, in order to terminate upon the surface of the teguments and to evacuate the fluids which are separated from the blood in the interior of these organs.

The glands which properly belong to this system are, the three salivary, the lacrymal, the liver, the pancreas, the mammæ, the testicles and the ovaria.*

* The sebaceous and mucous follicles, as well those which are isolated as those which occur in groups, as the muciperous glands of Peyer, (in the ilion) or rather those which open upon the tegumentary surface by common ducts (lacunæ,) may be placed under the same head as the glands that have just been enumerated, and from which they differ merely in being less complicated, but being, like them, mere prolongations of the teguments. Indeed, is not a slight degree of attention sufficient to convince us that there is no essential difference between the amygdalæ or the prostate, &c., and the lacrymal or salivary glands?

On the other hand, the term gland is sometimes applied to a number of parts which have only some resemblance as regards the more gross relations of form or texture. And without speaking here of the tongue, which, on account of its rounded contour, might be placed in the glandular system, we shall notice: 1st, the lymphatic ganglia, which are called *conglobate glands*, in contra-distinction of the true organs of secretion, which are termed *conglomerate glands;* 2d, certain rounded organs, which are enveloped by a membrane which varies in thickness, and sends prolongations into their interior: these organs, which Bichat has

Situation and arrangement.—The glands are found exclusively in the trunk, and are either in symmetrical pairs, and situated upon each side of the mesian line, as the lacrymal, the salivary, the mammary, the kidneys, the testicles and the ovaries, or they are single, and are placed upon the mesian line, or upon one side, as the pancreas and the liver.

Conformation.—The form of the glands is very variable; but they are always more or less rounded, and often flattened in one or more directions. They differ also still further in respect to their volume; what a difference is there between the size of the liver, one of the largest organs of the body, and the lacrymal gland?

Structure.—The anatomical composition of the glands results, 1st, from a purely cellular, or fibrous envelope, which is in relation by one of its surfaces, either with cellular or adipose substance, or with a serous membrane, and is confounded by the other with the tissue of the glands; 2d, from vessels, nerves, and excretory ducts, whose most minute ramifications are united by cellular tissue and form the proper parenchyma of the organ. In all the glands, except the liver and the kidneys, the parenchymatous substance is divisible into lobes and lobules, which result from the union of whitish, homogeneous particles. On the contrary, the organs to which we have just alluded, are composed of two substances, which are easily distinguished by

separated from the glandular system, are essentially vascular, are destitute of excretory ducts, and are, according to modern anatomists, true sanguineous ganglia, which are analogous to the lymphatic ganglia, and in which the blood that circulates in their interior is destined to undergo a process of perfection. The thyroid and thymus glands, the spleen and the capsulæ renales, compose the group of these organs, which have received the name of *adenoid* or *glandiform bodies*, and of which we can not give a general description, on account of the diversity of their form, their structure, and the obscurity in which their true character is still involved.

the difference of their colour. In the kidneys, these substances are disposed in layers, an exterior and an interior, or a *cortical* and a *medullary*, but in the liver, they exist every where simultaneously.

But in what relations do the most minute ramifications of the vessels and of the excretory ducts stand, so as to form the proper tissue of the glands? Shall we admit with Malpighi that the radicles of the excretory ducts are small vesicles or follicular pouches, in the parietes of which the blood-vessels terminate; or that the excretory ducts are, as was asserted by Ruisch, the immediate continuation of the vessels? Acknowledging that this point of minute anatomy is still extremely obscure, it is to the first of these hypotheses that we would cede the preference, following in this respect the example of the greatest modern anatomists. Indeed, the study of comparative anatomy teaches us that the glands are the mere agglomerations of numerous follicles which belong to the *canalicular* and ramified prolongations of the tegumentary membranes. "The muciperous glands, which are nothing but simple sacs, form the prototype of the glandular formation. Let us imagine that the branches of this elongated ramified sac unite with those of the vessels, and we shall have the most intricate gland, without there being any immediate communication between the blood-vessels and the excretory ducts."—J. F. Meckel.

The excretory ducts, after being successively joined so as to form large branches, finally unite in one or more trunks which terminate upon the surface of the teguments. In their course, which is sometimes very considerable, the trunks often present enlargements, which are small, as those of the mammary glands, or large and cystiform, as those which constitute the gall-bladder and the vesiculæ seminales: the urinary bladder may be considered as an enlargement common to the excretory ducts coming from each of the kidneys. The mucous membrane, which essentially

constitutes the glandular apparatus, gradually becomes thinner and more delicate in proportion as the ramifications of the excretory ducts become more numerous. This membrane, however, is strengthened and protected by cellular substance which is more or less compact, sometimes even fibro-elastic, and in some parts by a vascular erectile net-work, or muscular fibres. The glands contain numerous blood-vessels and lymphatics; and all, except the liver, receive exclusively arterial blood. This organ receives, besides its particular artery, a large venous trunk (vena portæ,) which is ramified in its substance, (See Vas. Sys.) In general, the veins of the glands do not exceed their corresponding arteries in capacity, as is the case in the other parts of the system; a circumstance which is owing to the loss which the blood, that is carried to them by the arteries, experiences in these organs.

Characters, physical and chemical properties.—Their colour, density and consistence, vary in the different glands, and can not be described in a general manner. The chemical characters of the compound glands depend upon those of the elementary tissues which contribute to their formation.

Vital properties.—The glands appear to be destitute of vital contractility, and in their healthy state, they are but little sensible; the testicle being the only one that manifests any considerable degree of sensibility when it is compressed. The presence of calculous concretions in the excretory ducts of some of these glands, and especially in those of the liver and the kidneys, generally occasions severe pain and distress.

Differences according to age.—The glands in the human embryo are developed in passing through the different stages of complication which are observed in the skin of animals; and this mode of development proves that these organs are nothing but more or less complicated appendages of the tegumentary system. Indeed, the parts which form the excretory canals are perceived to be, at first,

continuous with the teguments, which are afterwards successively ramified until the gland is completely formed. In the fœtus, these kinds of glands are composed of lobes and lobules, which, in some of them, as in the kidneys, subsequently disappear. The volume of the glands, which concur to the preservation of the individual, is generally comparatively greater in the early periods of life than in after age. On the contrary, the mammæ, the testicles and ovaries, which are destined to the preservation of the species, are usually small before the age of puberty, when they become larger and acquire more vitality: in old age they cease to act and fall into a kind of decay. The testicles and the ovaries, moreover, change their situation some time before birth.

Functions.—The glands serve to separate from the blood, which circulates within them, particular fluids which differ in the different kinds of glands, and are conveyed to the surface of the teguments by the excretory ducts. The separation of these products constitutes what is called *secretion*, which differs from the perspiration and follicular secretion only by the intricate structure of the secretory organ. The manner, however, in which the glandular secretion is effected, is still unknown, and all the knowledge we possess upon this subject is, that the blood, after its arrival in the capillary arteries, which are distributed in the proper substance of the organ, has some of its materials combined, either by virtue of a simple chemical re-action favoured by the dilatory course of this fluid, or under the influence of a vital action, exercised upon it by the tissue of the follicles of the gland. The changes in the vitality of a gland, and the state of its nervous system, have a great influence upon the nature and the quantity of its secretion; and from this combination results a peculiar fluid which is discharged into the excretory ducts, and conveyed by them to the surface of the teguments, or retained for a certain time in their cystiform cavities. The blood, which has not been employ-

ed in the formation of the humour to which we have just alluded, is taken up again by the radicles of the vascular centripetal system.

Pathological Anatomy.

There are few organs which present more congenial anomalies of volume, form and situation, than the glands. They are often larger and again much smaller than usual, either primarily, or, as is most ordinarily the case, accidentally: they are sometimes affected with atrophy, which may either result from their compression, or from the cessation of their functions. The lobular structure which is sometimes observed to continue in some of the glands, especially in the kidneys, depends upon their imperfect development. The kidneys are the organs which are the most subject to anomalies of number; thus, there have been instances where there was sometimes but one, and at others, three of these glands. The ovaries and the testicles are sometimes entirely wanting; and their situation also may be anomalous: thus, there have been instances where the ovaries passed out of the abdomen, and where one or both testicles remained in that cavity, after the time when they ought to have descended into the scrotum, and even during life.

The solutions of continuity of the glands cicatrize with difficulty, and have a tendency to become fistulous, because the secretions, flowing continually, prevent the re-union and agglutination of the lips of the wound.

The glands are extremely subject to inflammation; and this morbid state is capable of producing different phenomena in the different kinds of glands, and even of being propagated to the tegumentary membrane. It suspends, augments, or alters their secretion, and often induces the induration of their tissue by the exhalation of an albuminous or sanguineous fluid during the inflammatory process. This induration, which ordinarily accompanies the oblite-

ration of at least a part of the excretory ducts, often becomes schirrous or carcinomatous, when the inflammation continues to exist: these alterations are frequently consequences of chronic inflammations of the mammæ, the testicles and the ovaries. The glandular tissue is never produced accidentally; but the different transformations and accidental productions are observed in all of them, and particularly in the mammæ, the testicles and the ovaries.

Bibliography.

The treatises on general anatomy already quoted.

M. Malpighi. De viscerum structurâ, cap. II, in op. omn. De gl. conglob. Ep., p. 6. Operâ posth.

H. Bœrhaave et *Ruisch.* De structura glandul., etc.; *in* Ruisch op. omn.

Th. Bordeu. Recherches anatomiques sur les Glandes. Paris, 1751.

G. A. Haase. De Glandularum definitione. Lips., 1804.

CHAPTER X.

MUSCULAR SYSTEM.

SECTION 1.

General Observations.

Definition.—This system consists of an assemblage of organs—the muscles—which compose the greater part of the body, are characterized by a more or less evidently fibrous structure, and by extensive contractions, by virtue of which they are the agents of locomotion.

Division.—Bichat, struck with differences of form, the organization and functions which exist between the exterior voluntary, and the interior membraniform involuntary muscles, established two muscular systems, which he designated according to their most prominent and distinctive characters, by the names of the *muscular system of animal life*, and *the muscular system of organic life.* More lately, anatomists, aware that the relations which exist between these two systems in respect to their organization, their properties, &c., are too important to be separated in an absolute manner, have united them under the common denomination of the muscular system, and have divided the muscles themselves into two classes.

Structure.—The muscles consist of an assemblage of primitive microscopic fibres united in fasciculi, which are easily distinguishable by the naked eye (secondary fibres); but these fasciculi form still larger ones, which, by uniting

with others, form the muscles. In order to perceive the fasciculi, it is necessary to subject a muscle to the action of ebullition; we shall then be able easily to detach them under the form of flattened or prismatic filaments, which extend either throughout the whole length of the muscle, or they terminate before they arrive at its extremity, by uniting with the tendons or the aponeuroses. The filaments, or secondary fibres which compose the fasciculi, are always parallel, but this is seldom the case with the fasciculi which compose the body of a muscle; they being almost always oblique in respect to each other. Examined with the microscope, the fibres, like the fasciculi, present still smaller fibres, which appear to be the ultimate parts of the muscles, and are hence called the *elementary* or *primitive*, or simply the *muscular fibres.* The physiologists who have paid particular attention to the structure of the muscular fibre, are Prochaska, the Wenzells, Autenricth, Sprengel, Mr. Bauer, and Sir E. Home, Messrs. Dumas and Prévost, and M. Dutrochett. In the present day these fibres are generally regarded as small, somewhat flattened filaments, having every where the same diameter, and being composed of a series of globules which are exactly analogous to the white globules of the blood, and are united together by a perfectly transparent mucous, or gelatinous substance. Every thing else that anatomists have advanced upon the ultimate structure of the muscular fibre, is of a hypothetical nature. The muscular fibre, and consequently the secondary fibres, and the fasciculi, present, when they contract, transverse wrinkles, which are nothing but temporary folds that disappear as soon as the cause of contraction is removed. These phenomena are more conspicuous in the belly of the muscle than at its extremities, which are both drawn towards its middle.

Besides the proper substance of the muscles, which appears to be formed of globules, and the transparent medium in which they are disposed in linear orders, these organs

contain cellular tissue, blood-vessels, lymphatics, and nerves. The cellular tissue forms a general covering for the muscles, dips into their substance, and forms a sheath for each fasciculus, and probably for each elementary fibre: here, however, the existence of the cellular substance can only be admitted by analogy. The tenuity and consistence of this substance gradually diminish, in proportion as its divisions become more minute. (V. His. of Int. C. Tissue.) Adipose substance also occurs in the interior of the muscles, between their fasciculi, and even between their secondary fibres.

The number and caliber of the vessels of the muscles are considerable, and are proportionate to the volume of the different muscles which compose the two classes of the muscular system. The arteries having reached the cellular envelope of these organs, divide into numerous branches, which are distributed in different directions, between the fasciculi, and terminate by successive ramifications in the cellular tissue, and the secondary fibres, beyond which they can not be traced: we are still ignorant of the relations which exist between the elementary fibres, and the blood-vessels of the muscles. The muscles have but few lymphatic vessels; and the veins, which are larger and more numerous than the arteries, are divided into superficial and deep seated; the latter of which generally accompany the arteries. It is not, however, to the presence of these numerous vessels, but to another cause, which we shall hereafter point out, that we are to attribute the colour of the muscles; for this is not in relation with the quantity of the blood which penetrates these organs; it remains, notwithstanding the changes which the colour of the blood experiences in cases of suffocation. The nerves of the muscles are exceedingly numerous, and are derived, either from the encephalo-rachidian masses, or from the gan-

glionic system, accordingly as these muscles belong to the first or to the second class of the muscular system.*

In some instances the same muscle receives several nerves from different origins: in this case it appears, according to the researches of Mr. C. Bell, that the plurality of the nerves is not intended for the accumulation of a greater quantity of the nervous energy in the muscle, but to enable it to perform several kinds of motion. Let this, however, be as it may, it is certain that the nerves generally enter the muscles by following the course of the blood-vessels, proceeding either parallel with, or perpendicularly to the fasciculi and muscular fibres, in which they soon become undistinguishable. The imagination of the anatomist has supplied what inspection can not demonstrate in respect to the termination of the nervous filaments, and he has supposed that the substance of the nerves is either lodged in the cellular tissue, and communicates to it its conducting property (Isenflamm), or that a nervous atmosphere, emanating from these filaments, extends from the seat of innervation to their termination.

According to the microscopic observations of MM. Prévost and Dumas, it appears that the nerves of the muscles extend farther than they can be traced by the naked eye; that after a nerve has ramified a certain number of times, it becomes expanded, and that its secondary fasciculi shoot out, and give off filaments which traverse the muscular fibres at a right angle, and either form a kind of loop and return to the same nerve, or anastomose with the neighbouring branches. These transverse filaments are very numerous and near each other; and, in general, the small nerves which furnish them proceed parallel with the muscular fibres; and in some instances two of them pass together, and in such a manner as to give off an equal num-

* We have already seen to what part of the cerebro-spinal masses the nerves correspond which preside over the voluntary motions.

ber of filaments which intersect the muscular fibres perpendicularly. From these observations it would really appear, that the nerves have no termination, since their ultimate divisions anastomose with the neighbouring branches, or return to join their original trunk.

Characters, physical and chemical properties.—The colour of the muscles varies, according to the class to which they belong, from a grayish white to a deep red; and appears to be much more intense in proportion as the muscle is thick and large; there being scarcely any, where the fibres are isolated. The colour of the muscles does not depend upon their vascularity, but upon the presence of a colouring matter which is analogous to that of the blood: by washing a portion of muscle, the colouring matter will remain suspended in the water; it may also be readily separated by boiling, and when a muscle is exposed to putrefaction, it immediately disappears.

The muscular fibre is semi-transparent, soft, slightly elastic, endowed with the power of resisting considerably during life, especially during its state of contraction, and enjoying a remarkable degree of contractility. By slow desiccation it is rendered more prominent, transparent, and hard. After death the muscular fibre yields readily to such efforts as have a tendency to break it.

The action of ebullition, the dilute acids, alkohol, and the different saline solutions, render the muscles more consistent and more evidently fibrous. The chemical analysis of muscular flesh has furnished the carbonate and phosphates of lime, of soda and ammonia, a small quantity of albumen, gelatine, osmazome, and a considerable proportion of fibrin.

The marked predominence of the fibrin in the chemical composition of the muscles, establishes a very striking relation between them and the clot of the blood, and tends to prove, that the sanguineous globules and those of the muscular fibre, which are already identical by their form, are also by their chemical nature.

Vital properties and functions.—The muscles possess a middle degree of sensibility in the healthy state, but in certain morbid affections, especially in inflammations, their sensibility becomes considerably exalted. They enjoy the highest degree of *vital contractility* or *irritability* (Haller,) a property upon which depends the character which they enjoy in the animal economy.

What are the phenomena of this contractility of the muscles, or rather what is contraction? When a muscle acts it becomes shorter and thicker, as well as more dense and hard. The first of these phenomena being the most important, and the others being mere consequences, it is it which has induced physiologists to give to the muscular action the name of *contraction.* It has been often asked whether, during contraction, the muscles gain exactly in thickness what they lose in length; and whether their volume augments, diminishes, or remains the same. The best conducted and most satisfactory experiments upon this subject, and amongst others, those of MM. Meckel, Prévost and Dumas are favourable to the last hypothesis. When the muscles contract, they become corrugated, but do not undergo any change of colour, as has been supposed by some anotomists.—Having thus briefly pointed out the changes which a muscle experiences when in a state of action, we shall next inquire what phenomena takes place in the different parts of the muscles? The muscular fibres are drawn in a zigzag direction throughout the whole extent of their length, and this in such a manner that the apaces of the sinuositus which they form are always the points where the nervous filaments intersect the fibres at a right angle, (Prévost and Dumas) so that the contraction is owing to the sinuous direction of the muscular fibres. Physiologists have endeavoured to determine the extent of the shortening which the muscular fibre experiences: during the state of contraction, according to Bernouilli, it is as one third to that of the fibre; while Prévost and Dumas esti-

mate it at one fourth, according to the extent of the angles formed by the zigzag direction of the fibre,—a fact which is confirmed by direct observation. The possible degree of rapidity of muscular contraction varies in the different muscles; but it is always considerable. In certain muscles, a part of the fibres remain at rest while the others contract: this phenomenon is chiefly observed, as has been proved by the experiments of Mr. C. Bell, in those muscles which receive their nerves from different sources.

When the muscles contract, they acquire elasticity, and the force which they sometimes display during this state, is so great as to break their connexions with the tendons and the bones: this force is in direct ratio with the number of their fibres.

Physiologists have at all periods endeavoured to explain muscular contraction, and have assigned to this phenomenon, either mechanical or chemical causes, according to the prevailing theories of the time. Haller, after having refuted such explanations as these, thought he had ascertained the true cause of contraction, and asserted that it took place by virtue of a peculiar property, which he termed *irritability*, and which since the time of Bichat, has received the name of *contractility:* but this was merely expressing a fact in an abstract manner, and not explaining it. It is to MM. Prévost and Dumas that we are indebted for the most ingenious hypothesis that has hitherto been proposed upon this subject. These experimenters assert, as we have already had occasion to state, that the nervous filaments, which are distributed to the muscles, intersect their fibres at a right angle, and are of opinion, that these filaments are traversed by a current of galvanic fluid which attracts them towards each other, and that this attraction is the cause of the zigzag direction of the fibres to which the nerves are attached. According to this theory the muscular fibres are passive in the phenomena of contraction, while the nerves themselves are the true agents.

Several physiological and pathological facts also go to support this explanation. The analogy which is supposed to exist between the cause of the vital contraction of the muscles and that of the phenomena of galvanism, would appear evident by the contractions which a dead muscle, or simply its nerves manifest when they are exposed to the action of the galvanic pile. These, however, are mere hypotheses, and in the present state of our knowledge we are still ignorant of the proximate cause of muscular contraction; though it is otherwise with regard to the conditions of the muscles themselves; for we know, 1st, *that it is necessary for a muscle, in order to produce vital contractions*, to be (a) in a healthy state; (b) that its communications with the heart by means of the vessels, and with the nervous centre by means of its nerves, should not be interrupted; and (c) that when the nervous centre is in a state of disease it suspends its influence upon the muscles. 2d. *In order that contraction may take place*, it is necessary there should be an exciting cause; this does not always exist, nor is it the same in all the muscles. Thus, the will acts only upon the muscles of the first class, while all those of the second contract under the influence of the moral affections, the irritation of the encephalic centre, the stimulus of the internal and the external teguments, the sthenic state of the membranes, or the cellular envelope of the muscles, and under the direct mechanical, chemical, or galvanic excitement of the muscles, or of their nerves alone.

When the cause of contraction ceases to act, the organ recovers its primary dimensions, a phenomenon which some anatomists consider as a vital action, and not as the simple effect of the elasticity of the fibres; this opinion, which is entertained by J. F. Meckel, does not appear to be more plausible than that of Berthez, who attributes to the muscles *a power of fixed situation.*

Mode of development and differences according to age.—At the commencement of uterine life, the muscles

are confounded in the mucous mass which represents the cellular tissue: their fibrous structure is not distinct until about the third month; but the pulsations of the heart, which begin at a much earlier period, indicate a precocious organization of the tissue of this organ. The muscles are at first soft, gelatinous, and very pale. According to Bichat, their galvanic irritability is much less during fœtal life than in the subsequent periods; while the experiments of M. Meckel go to prove the contrary.

During infancy, the muscles are still pale and soft, and have a much smaller proportion of fibrin than subsequently; though their movements are more prompt and easy than in the following periods of life.*

In the adult, the muscles are at the maximum of their colour, their fibrinous composition and vital energy; their form is more distinct; their movements less rapid, but more sure and steady than in the infant. In old age, the muscles become pale and acquire a certain degree of hardness and rigidity, and their contractions also become slow and feeble. In the female the muscles are, *cœteris paribus*, rounder, more soft, and less powerful than in the male; and their contractions are also more feeble and rapid.

There do not appear to be any other differences between the different varieties of the human races, in relation to the muscular system, than those which generally result from the health of the individual and his mode of living; civilized people, therefore, enjoy a very marked superiority over savages, in respect to the development and energy of their muscles.

After death, the muscles may be observed to contract, during a certain time, under the influence of certain stimu-

* Supposing that this circumstance is concomitant with the imperfection of the organization of the muscular fibre, and with a great susceptibility of the nervous organs, we are induced to regard these last as the *true agents* of contraction.

li; but, as regards this, it is to be remarked, 1st, that the time, during which the muscles remain sensible to artificial excitement, varies in the different muscles; 2d, that all of them cease to be irritable to the action of one stimulus, while they are still so to another, and that, in this respect, the organs of which we are treating can not all be placed in the same class; thus, the heart is still irritable under the influence of mechanical agents, after it has ceased to be so by the galvanic action, even after the contractility has been exhausted in every other part of the system: on the contrary, the exterior muscles are still irritable by the action of the galvanic pile after they have ceased to be so by mechanical agents.*

The muscular contractility remains until about twenty-four hours after death. The cause of this, and the prior state of the subject greatly influence the irritability of the muscles in the dead subject. When the subject has died suddenly in consequence of violence, or apoplexy, and all other things being equal, the muscles retain their irritability for a much longer time than under ordinary circumstances. When the passage from life to death has been less sudden, the muscles contract a much longer time under the influence of external excitants, in proportion as the disease has been less protracted, and has had less influence upon the assimilative process. In persons who die

* Several experimenters have endeavoured to point out the order of succession in which the muscles cease to be capable of contracting. Haller, Frosiep, and Nysten, have left us different results upon this subject. Those, however, which the latter physiologist has obtained from his experiments upon decapitated subjects and upon animals, appear to deserve the most confidence. According to him, the irritability leaves successively the aortic ventricle, the large intestine, the small intestine and the stomach, the urinary bladder, the pulmonic ventricle, the œsophagus, the iris, the exterior muscles of the trunk, those of the inferior extremities, and finally those of the superior extremities, and the right and the left auricles.

from the action of the deleterious gases, such as the carbonic, the sulphurous, the hydro-sulphurous, &c., or from the stupifying poisons, the muscular irritability promptly disappears.

When the muscles are no longer susceptible of contracting under the influence of stimuli, they become rigid and cold. Nysten considers the first of these effects as the last phenomenon of irritability, an opinion which is contradicted by that which regards the nerves as the true organs of muscular contractions: indeed, the cadaverous rigidity of the human subject, and in the scale of animals, is much harder and more precocious as the nerves lose more rapidly ther galvanic excitability. This fact would induce us to believe that the phenomenon to which we have just alluded has no analogy with the true muscular contractions; perhaps we ought rather to refer it to those contractions which are observed by dividing certain tissues in the dead body, and which the immortal Haller has attributed to a *vis mortua*, and Bichat to the *contractility* of tissue, both of which are, however, by no means capable of affording the true explanation. The muscular contractions have for their object, either to impart movements to the solids or fluids, or to maintain them in their proper situation. The mode of action of the muscles and the great variety of its results depend upon the number, the disposition and length of the fibres and fasciculi, &c.; but chiefly upon the state of firmness or degree of mobility of the points to which they are attached.

The muscles are called *congeners* or *antagonists*, accordingly as they act in the same or in opposite directions. The antagonism is chiefly observed between the muscles of the first, but sometimes also between those of both classes, as for instance, between the sphincters and the muscles of the fecal and urinary excretions. The contraction of one muscle is always accompanied by that of its congeners, and by the relaxation of its antagonists.

Pathological Anatomy.

The muscles sometimes present mal-conformations which are almost always congenital, and consist chiefly in an excess or defect of length, divisions, anomalies of attachment &c. They are frequently observed to be in a state of atrophy and hypertrophy: the first is the result of their want of action, and is chiefly observed in cases of paralysis, or where the muscle has been exposed to protracted compression; the second is the effect of too severe exercise, and is observed only in the interior muscles, and especially in the heart. The displacement (luxation) of the muscles has only been observed in cases where the aponeurotic envelopes of the muscles were divided. The muscles are sometimes susceptible of experiencing transverse ruptures in consequence of violent contractions, either of themselves, or of their antagonists, or under the influence of sudden and excessive extension: these solutions of continuity, however, chiefly result from the violent contractions of the muscles at the point of union of the muscular fibres with the tendons, or the aponeuroses of insertion. The heart is sometimes ruptured in consequence of its violent contractions, in certain cases of dilatation of its cavities (aneurism), especially if its parietes are at the same time thin and weak.

When a muscle has been divided transversely, either in consequence of rupture, or by a cutting instrument, the borders of the solution of continuity separate, and immediate re-union can not be effected; but the extremities of the organ secrete a fluid which fills up the space between them, becomes organized, and ordinarily acquires the texture and appearance of fibrous tissue. This intermediate tendinous part, at once isolates and re-unites the two parts of the muscle; but we are ignorant whether they both continue to contract. Be this as it may, it is evident that the movements which are produced by the muscles thus re-

united, are for a long time feeble, and seldom recover completely, their former *extent* and firmness.

It is supposed that in proportion as the separation and the tendinous part of the muscle are more considerable, the longer and the more imperfect will be the re-establishment of its motions. Moreover, as the tendinous part never acquires all the firmness and resistance of the muscular fibre, and as it remains extensible, it neutralizes in great measure the effects of the contraction of the muscle. Wounds of the muscles which are attended with denudation and loss of substance, are covered by a cicatrix, which results from a process similar to that which we have described in the first chapter.

Inflammation of the proper substance of the muscles is still doubted; but their cellular tissue is often inflamed, as is satisfactorily proved by the collections of purulent matter which are observed between their fasciculi. In some instances, the muscles are remarkably flaccid and pale; and we not unfrequently meet with a gelatinous substance between their fasciculi and fibres, in consequence of rheumatism. Are the fatty transformations of the muscles only apparent, as is supposed by Béclard, and do they consist merely in a preternatural development of the inter-fascicular adipose tissue of these organs, in those cases, where their pale and shrivelled fibres are easily confounded with the adipose substance?

The muscular tissue is seldom affected with schirrous and carcinomatous degenerations; and as to its accidental development, all the cases that have been noticed may evidently be referred to morbid productions, whose appearance created some illusion. May we consider with some physiologists, the development of the muscular texture of the uterus during pregnancy as a kind of temporary accidental production?

SECTION 2.

Of the Exterior Muscles.

Synonyma: Voluntary muscles, muscles of animal life (Bichat), muscles, properly so called.

Definition.—The exterior muscles are those which, being spread beneath the external tegumentary, and around the osseous system, are subject to the will.

Situation.—The exterior muscles are in relation with the osseous or cartilaginous parts of the skeleton, with the skin, the cartilages of the larynx, the organs of the senses, and with the orifices of the digestive, the genital and urinary passages. Most of these muscles are in pairs, and are situated on each side of the body; some, however, are single, and extend from the mesian line to either side.

Number.—Anatomists are not agreed as to the number of the exterior muscles; some include in one the fasciculi, which others regard as so many distinct muscles; according to the differences of their calculations, they vary in number from three to four hundred.

Volume, form, and arrangement.—There is a very great difference between the volume of the different muscles: to be convinced of this, it is only necessary to compare the triceps cruralis, and some of the other large muscles of the trunk, with the small muscles of the bones of the ear. The muscles, like the bones, may be divided according to their form, into *long, flat,* and *short.* The first belong more particularly to the extremities, and the second to the trunk. The third occur chiefly on the head, the neck, the hands, the feet, and generally around the short bones. The form of the muscles, also, which compose each of these groups, varies very considerably. Most of the exterior muscles present tendinous or aponeurotic extremities, one of which is termed the *head,* and

the other the *tail;* while the intermediate or fleshy part is called the *belly*. The belly of the muscle is either formed of a single fasciculus, or it consists of several very distinct bundles, which are separated by cellular tissue, as in the deltoid, and the glutæus maximus; at other times, the body of the muscle is interrupted in its length by tendinous fibres, which divide it into several bellies, as in the digastricus of the neck, and the rectus of the abdomen. In some instances one of the extremities of the muscle is divided into two, and even into three portions, as is the case with the biceps, and the triceps brachialis and cruralis, &c. To these muscles may be compared the serrated muscles of the trunk: besides all these, there are other muscles which are simple throughout their whole extent, and have a common tendinous extremity, as for instance, the latissimus dorsi, and the teres major, which are inserted by a single tendon into the os humeri. The muscles are always symmetrical on each side of the mesian line; the diaphragm forming the only exception to this rule. They are almost always attached through the medium of their fibres to the periosteum, to the perichondrium, and to the organs of the senses; the fleshy fibres of the cutaneous muscles, however, furnish an exception to this rule, they being immediately inserted into the dermis, whose tissue, as we have already seen, greatly resembles the fibrous. The muscular fibres are often inserted into the membranous prolongations which are sent between the muscles by the aponeurotic envelopes.

Structure.—The bundles and fasciculi which compose the muscles are much more evident in the exterior than in the interior muscles; the fasciculi of some of the former are often so distinct and voluminous that one might consider them as so many muscles. The muscular fibres pass in various directions, being sometimes parallel with each other, or in radiating lines, &c. In the first instance, the fibres unite and present a straight direction, or they pass

obliquely, either between two aponeuroses which are spread upon the muscle in part or in whole, or upon a tendon that is first concealed in the interior of the muscle, which often presents in its free part the appearance of the plume of a feather, either upon one or both sides: hence the names of *semi-penniform* and *penniform* muscles. It would be foreign to our subject to point out the different relations which exist between the muscular fibres, or between them and their tendinous parts; they are details which belong to descriptive anatomy: we shall only observe that the adhesion of the muscular fibres with the tendons is very firm and intimate. The quantity of the cellular tissue of the muscles is in direct ratio with their volume, the size of the fasciculi, and the interstices which separate them. In the general observations of the muscular system we have already seen the relations which exist between the vascular system and the muscles, and it only remains to observe, that their nerves are extremely numerous, and are derived chiefly from the spinal marrow, and the medulla oblongata; though some of them, as the muscles of the neck and pelvis, are furnished with filaments from the ganglionic nerves.

Physical properties.—The colour of the voluntary muscles, as every body knows, is of a deep red. The density and power of resistance of these organs are, as is supposed by anatomists, in direct ratio with the number of their fibres, and exceed those of the muscles of organic life, &c.

Vital properties and functions.—The sensibility of the voluntary muscles is scarcely observable in the healthy state: they contract with much force and rapidity under the influence of the encephalic action; and when they are removed from this influence, they may still be excited to contract by the stimulus of galvanism. The attitude and movements of the skeleton, the motions of the organs of the senses, of the skin, the voice, of speech, and deglutition, the retention and expulsion of the excrementitial matters, are all the result of muscular contractions. These

movements are either simple or compound: they are simple when they take place in the direction of the contraction; compound when the muscles which produce them have two or more different directions.

The general terms of *congeners* and *antagonists*, are applied to the flexors and extensors, the adductors and abductors, and to the elevator and depressor muscles, &c. We generally observe different degrees of power between the antagonist muscles, which can only be studied in those which perform the motions of flexion and extension. Since the time of Borelli, these differences have been considered as being advantageous to the extensors; but it appears that this opinion is correct only with respect to some parts of the body, as for instance, the superior extremities. In the disposition of the muscles there exist some very important circumstances, which render it necessary that there should be a considerable force on their part in order to produce motion; these are, 1st, their levers of the third kind; 2d, the very acute angle which they generally form by their insertion into the apophyses, or into the extremities of the bones; 3d, the resistance of the antagonist muscles. We shall not include under these circumstances the obliquity of the fibres with respect to the tendons into which they are inserted, since this obliquity increases the number of fibres, and amply compensates for the loss which each of them sustains: as to the frictions of the tendons and of the articular surfaces, they are facilitated by the presence of the sheaths, and of the synovial membranes, in such a manner, that they can scarcely be considered as obstacles to be overcome by the muscular power. In relation to the first two circumstances which we have just presented as unfavourable to the muscular power, it may be observed; 1st, that if the levers of the third kind are more difficult to move, they are the most favourable to the extent and rapidity of motion; 2d, that the facility of motion is confined to the form of the body, and that this form would be very

unfavourable to locomotion, if the muscles were attached to the bone at a right angle: we perceive, moreover, how the extent of motion would be impaired by such an arrangement.

SECTION 3.

Of the Interior Muscles.

Synonyma: Hollow muscles, involuntary muscles, muscles of vegetative functions, muscles of organic life.

Definition.—The system of the interior muscles comprehends the fleshy parts which enter into the structure of the organs of the involuntary functions: these parts are, the heart and the planes of the muscular fibres which enter into the composition of the teguments of the gastro-pulmonary and the genito-urinary passages.

Situation.—All the interior muscles are situated deeply, and belong, with the exception of the heart, to the internal tegumentary system.

Volume, form and disposition.—The volume and form of these fleshy parts generally depend upon those of the hollow organs, to the structure of which they contribute. They form muscular laminæ which vary in thickness, and serve to strengthen the internal membranes of the organs to which we have just alluded. These laminæ, which are very thin and few in the digestive canal and the urinary bladder, are more numerous and thick in the heart, are always interlaced with each other, and are generally circular: in the œsophagus and the large intestines they are longitudinal and intersect the first, which are exterior to them, at a nearly right angle.

Structure.—The fibres which compose the muscles of organic life are sometimes interlaced; sometimes in juxtaposition and united in flattened fasciculi: in this case they sometimes form almost complete rings, as may be observ-

ed in the greatest part of the intestines. In general, these fibres are short; those even which compose the longitudinal fasciculi of the œsophagus and the large intestines, far from having the length of these organs, terminate after a short course, to give way to others: they are more or less distinct according to the organ that is examined; those of the uterus being only slightly manifest during pregnancy. The tendinous parts of the interior muscles occur only in the heart, at the extremities of its columnæ carneæ, at the entrance of its cavities, and in the auriculo-ventricular valves; the fibres of the other interior muscles terminate in the submucous cellular tissue, which we have already described in the first chapter of this manual.

The interior muscles present but little cellular tissue: their vessels appear to be more numerous than those of the exterior muscles; but, as has been already observed, the vascular branches which penetrate into their tissue should not all be regarded as belonging to these, for the most of them are distributed to the internal teguments. The nerves of these are less numerous than those of the preceding muscles: most of them are derived from the ganglia, and anastamose in some of the organs with the cerebro-spinal nerves,—which is observed in the œsophagus, the stomach, the rectum and the urinary bladder.

Physical characters.—The muscular fibres which cover the internal tegument are of a pale grayish appearance; those of the heart, however, are of a deeper red than those of the voluntary muscles. Bichat thought that the muscular fibres of organic life were more resisting than those of animal life; but the contrary appears to be the more probable, though if there be any difference in this respect, it has not yet been proved.

Vital properties and functions.—The sensibility of the involuntary muscles is very obscure, and can with difficulty be appreciated and distinguished from that of the tissues with which they are connected. Harvey has cited the case

of a man, whose heart, being exposed in consequence of a caries of the sternum, could be irritated without pain to the patient. Bichat supposed that the first sensation of hunger results in part from the long continued state of contraction of the muscular fibres of the stomach. The contractions of the muscles of organic life are physiologically determined by the contact of certain agents, such as the blood for the heart, the aliments, the chyme, the chyle, and the excrementitial remains for the muscular planes of the digestive canal, and the urine for those of the bladder: it ought to be observed, that these different substances stimulate the organs to which we have just alluded, only through the medium of the mucous or vascular tunic which covers them. These contractions may also be produced by mechanical stimulants; galvanism, on the contrary, operates with difficulty, while we recollect with what facility it unfolds the irritability of the voluntary muscles. A great number of morbid states of the economy determine or accelerate sympathetically the muscular contractions of the heart and of the submucous fleshy planes; but more frequently those of the first. Violent moral affections give rise to the same result; but, on the other hand, the muscles of which we are speaking are more or less independent of the encephalic action: we have no power of suspending the contractions of the heart, though Bayle, it is said, had this faculty, and Cheyne refers to a similar case; nor can we by the direct act of our will, contract our alimentary canal; and we can very readily explain the influence of this last upon the urinary and fecal excretions, by that which it exercises upon the exterior muscles which assist in its functions. Notwithstanding this independence, we find that it is not absolute in many diseases where the cerebro-spinal centre is injured, without the muscles of organic life being affected, and that many affections of the encephalon and spinal marrow paralyse more or less promptly the organs of which we are treating: this is particularly the case with

the urinary bladder and the rectum, on account of the nerves which they receive from the spinal marrow; so that when this is injured, it gives rise to paraplegia, occasioning most frequently a simultaneous paralysis of these parts.

The contractions of the interior muscles have for their object the contraction and shortening of the hollow organs of which they form a part: the variety which is observed in the direction of their fibres, is necessary, in order that this contraction may accommodate itself to the form of these organs, and take place in every direction. From this disposition, the solids or fluids which are contained in the organs just alluded to, receive a motory impression, either for the purpose of propelling these substances from one part to another, or to expel them from the economy. The interior muscles have no antagonists that may-be compared to those of the exterior muscles; though we may, in some measure, consider as such: 1st, the foreign substances which distend the parietes of the hollow organs, of which the interior muscles form a part; 2d, the different portions of the hollow organs with respect to each other: for instance, the auricles of the heart with respect to its ventricles, the first being at their height of contraction when the second are at their minimum of relaxation, and *vicê versâ;* the same also obtains with respect to the neck of the uterus and of the urinary bladder in relation to the bodies of these organs; 3d, the longitudinal fibres of the digestive canal with respect to circular fibres, the contraction of the first giving rise to the elongation of the second; 4th, sometimes the voluntary muscles, as for example, the sphincters of the anus and the bladder with respect to the muscular fibres of these organs: indeed, the latter are relaxed while the former contract. In some instances, also, the exterior muscles act as congeners of the interior; thus, during vomiting, the act of defecation, of urinary excretion, and of parturition, the abdominal muscles contract simultaneously with the stomach, the rectum, the bladder and the uterus.

Bibliography of the Muscular System.

The general treatises already cited.

Proschaska. De carne musculari tractatus anat. physiol. in op. minor.; pars I. Viennæ, 1820.

Prévost et *Dumas.* Mémoire sur les phénomènes qui accompagnent la contraction de la fibre musculaire; dans Journal de physiologie expérementale, t. III, p. 301—339.

Dutrochet. Observations sur la structure intime des systèmes nerveux et musculaires, et sur le mécanisme de la contraction chez les animaux; dans ses Recherches anat. et physiol. sur la structure intime des végétaux et des animaux, et sur leur mobilité. Paris, 1824.

Haller. Mêm. sur la nature sensible et irritable des parties du corps humain. Lausanne, 1756—1759.

—— De partibus corp. humani irritab.; in Comm. Gotting. Tom. II et in Nov. Comm. Gotting. Tom. IV.

Weber. De initiis ac progr. doctrinæ irritabilitatis. Hallæ, 1783.

Borelli. De motu animalium. Leyde, 1500.

Barthez. Nouvelle mécanique des mouvemens de l'homme. Carcassonne, 1798.

Roulin. Recherches sur les mouvemens et lès attitudes de l'homme; dans Journal de physiol. expérim. vol. I et II.

Rites. Dict. des sciences médicales; art. Muscle, Musculaire et Myologie.

G. Sedillot. Mém. sur la rupture muscul.; dans Mém. et prix du la Soc. de méd. de Paris, 1817.

Hausbrandt. Dissert. luxationis sic dictæ muscularis refutationem sistens. Berolini, 1814.

Fr. Schnell. De naturâ reunionis musculor. vulneratorum. Tubingæ, 1804.

APPENDIX,

CONTAINING AN

ACCOUNT OF THE ACCIDENTAL TISSUES.

To complete the history of the anatomy of the tissues, it remains only to speak of those which are developed accidentally. The accidental tissues are divided into those which have more or less resemblance to the natural tissues, and into those which can not be referred to any of the tissues of the healthy organs. The first constitute either the true accidental productions or simple transformations; and, as we have already had occasion to speak of the systems to which they belong, we shall at present treat only of those which recede from the type of the normal organic formations. From the fact, that each of these tissues varies according to the part where, and the time in which it is examined, and also from the fact that they often bear very delicate shades of resemblance to, and are often combined with, other tissues, authors have given very different classifications, which it would be superfluous to enumerate on the present occasion. Confining our attention to the morbid tissues that have been most generally admitted, and are the best characterized, we shall successively describe the tuberculous productions, schirrus, cancer or the encephaloid substance of M. Laennec, and the melanotic sub-

stance.* But before entering into the particular history of each of these, we shall point out, in a cursory manner, their general characters, and the principal notions that have been advanced with respect to their cause and mode of development.

The morbid tissues may be developed in every part of the system, but they are more frequent in those parts which possess a considerable degree of vascularity. They occur most frequently in a single point, though sometimes they exist in several simultaneously. The relations of situation of these tissues with the organs, may be referred to two kinds; in one they occupy the interstices of the substance of the organ, which increases in size, and its substance, crowded and compressed by the presence of the morbid production, decays and disappears. In the second kind, they are formed on the exterior of the organ which they displace or destroy by compression, and finally, as in the preceding case, occupy its place.

By some authors these morbid productions are considered as degenerations of the normal tissues; while others profess, on the contrary, that they constitute new productions, which are developed amongst the natural tissues. M. Meckel, amongst others, admits, that by an aberration of the nutritive process, analogous to inflammation, the organs become the seat of an effusion of albuminous fluid, which becomes imperfectly organised and assumes the different forms of the preternatural tissues. M. Broussais also attributes the production of these accidental formations to inflammation of the capillaries, especially to that of the lymphatics; Bayle and Laennec, on the contrary, regard this phenomenon as the result of a morbid individual diathesis; but this opinion is supported by but few persons, the

* The other accidental tissues admitted by Laennec, viz. *cirrhosis, sclerosis*, and the *squamous* tissue, do not appear to have been hitherto sufficiently studied, to be described with precision.

greater number of anatomists and pathologists embracing the theories of MM. Broussais and Meckel.

The accidental tissues, which have no analogy with those of the healthy system, do not, in general, present any appearance of texture, though most of them contain blood-vessels and traces of cellular tissue. In proportion as they become appreciable, their consistence undergoes inverse changes of those which are experienced, in this respect, by the normal tissues; that is, instead of augmenting, their consistence progressively diminishes, so much so, that these tissues, though sufficiently hard in their first crude stage, become soft, and finally, even fluid; they have a tendency to escape from the system, and exist only temporarily: instead of contributing to some function, they at first, mechanically impede the action of the neighbouring organs or of those into which they are infiltrated, often produce inflammation, and, subsequently, in their stage of decomposition, cause general and serious disorders, particularly emaciation and hectic fever, the precursors of a more or less speedy death. At this stage, also, the productions of which we are speaking, have a great tendency to become numerous, and are developed, sometimes, either simultaneously, or successively in different parts, so that the system appears to be the seat of a general infection.

ARTICLE 1.

Of Tubercles.

Tubercles are homogeneous caseiform productions, which are either infiltrated into the areolæ of our organs, or are united in rounded masses. They occur chiefly in the lungs, in the tissue of the lymphatic ganglia (scrofulous tubercles,) in the cellular tissue, on the surface of the serous and the mucous membranes; in fact, there is no organ in the body that may not be affected with them. The tuberculous sub-

stance is, at first, in a fluid state, and of a whitish appearance; but it gradually acquires more and more consistence, becomes yellow and assumes the aspect of cheese, constituting what is called its stage of crudity: at this period, the tubercle is often enveloped by a soft membrane which is subject to various changes. Such is the stage of development of the tuberculous masses. They have neither vessels, nor cellular tissue, in a word, no trace of organization. After some time, they undergo a softening, which begins at their centre and extends gradually towards their circumference: the tubercles are now reduced either to an opake, yellowish, homogeneous, semi-fluid substance, or they are observed in the form of flocculi, which resemble the cheesy substance of milk. In this stage, the tuberculous substance leaves the point in which it was collected, opens a passage for its escape from the system, and the cavity which it occupied often disappears in consequence of the approximation and adhesion of its parietes: in other cases, however, the tuberculous matter remains, and the parietes, which are ordinarily formed by the new membrane which serves as a cyst to the tubercle, continue to secrete puriform matter, or this membrane, which is at first somewhat analogous by its organization to the mucous teguments, becomes cartilaginous or even osseous; a case of which has been lately reported by M. Laennec, to the Royal Academy of Medicine.

Bayle regarded the tubercles as a production *sui generis*, different from the grayish transparent miliary granulations, of which he has left an excellent description. Laennec, admitting the peculiar nature of tubercles, and attributing them, in the same manner as Bayle, to a peculiar individual diathesis, disagrees with this author in considering the miliary granulations as the first stage of development of the tuberculous masses. M. Broussais does not separate these productions, and asserts that they consist in an alteration of the the lymphatic ganglia, produced in conse-

quence of inflammation.* M. Andral, the younger, has been led, after an attentive examination of pulmonary tubercles and granulations, both in the human subject and in the horse, and after a minute dissection of the lobules of the lungs, to conclude: 1st, that the granulations of Bayle are not incipient tubercles, but portions of the lobules of the lungs, insulated and inflamed;† 2d, that the pulmonary tubercles are not composed of a tissue, since they do not possess the anatomical characters; 3d, that they are the product of a morbid secretion, preceded by an active sanguineous congestion, which does not necessarily constitute inflammation; 4th, that it is probable, but has not been proved, that the lymphatic ganglia of the lungs are often the seat of tubercles, (the lymphatic vessels of the lungs and of other organs sometimes contain a substance which appears to be identical with the tuberculous matter;) 5th, that tubercles occur in several of the tissues which compose the lungs..

ARTICLE 2.

Of Schirrus.

Schirrus, which is often confounded under the name of encephaloid cancer, is a very hard tissue, of a whitish or bluish appearance, and is usually presented under the form of irregular masses. It is most frequently observed in the neck of the uterus, the pyloric orifice of the stomach, and in the glands; but there are few organs which may not be its seat. In its state of crudity, the schirrous tissue is of the consistence of fibro-cartilage, and grates under the scalpel. By examining its texture, we may observe traces of the cellular and the fibrous tissues, but seldom any ves-

* Morton and Portal had already considered pulmonary tubercles as engorged lymphatic ganglia.

† When the lymphatic ganglia are inflamed, they often assume the physical characters of these granulations.

sels; interiorly, it is often cellular and presents regular radii like those of the turnip. This tissue often becomes softened, and is converted into a gelatinous or syrup-like substance, which is of a white, transparent appearance, or of a reddish, yellowish, or greenish gray colour. The schirrous tissue presents many varieties, and amongst others, those which Mr. Abernethy has distinguished by the names of the *tuberculous*, the *mammary*, and the *pancreatic sarcoma.* The first is distinguished from schirrus, properly so called, by its lobular form.

ARTICLE 3.

Of Encephaloid or cerebriform Cancer.

The tissue to which M. Laennec has applied the name of *encephaloid substance,* is one of those which pathologists designate under the name of cancer, and which has been improperly called fungous inflammation (Burns,) fungous hematodes (Hey and Wardrop,) and medullary sarcoma (Abernethy.) This tissue is often found in the uterus, the ovaries, the testicles, the mammæ, the brain; and, in fact, in every organ. It is presented under the form of lobular masses with convolutions like those of the brain: these masses are often covered, either in part, or in whole, by a membranous production, which is connected to them by a very loose, vascular substance, and often acquires the consistence of cartilage. In some cases, the cerebriform substance is infiltrated into the tissue of the organs, especially in the uterus.

In its state of crudity, the encephaloid tissue is of a white, rose, or purple colour, either partially, or in a uniform manner: it is less consistent than schirrus, and more firm than the substance of the brain. It is traversed by blood-vessels whose parietes are thin and brittle, and are derived from those which are found in the soft cellular tissue which

covers the encephaloid masses. Notwithstanding the analogy which exists between the encephaloid and the cerebro-spinal substances, both with respect to their form and their apparent texture, we ought not to admit the identity of their tissues.

The cerebriform cancer soon becomes soft, and is converted into a pultacious substance, which is of a reddish white, and sometimes grayish colour, and resembles, in some respects, the softened substance of the brain. It often happens, at this period, that the vessels of the preternatural tissue break, and produce an effusion of a considerable quantity of blood: under these circumstances, the fluid is either discharged from the system at the moment of the rupture, or it is effused and operates in the same manner as the sanguineous apoplexies of the cerebral tissue, which are not followed by immediate death. The contact of the air greatly accelerates the softening of the cerebriform substance, and its putrid decomposition.

ARTICLE 4.

Of Melanosis.

This term has been applied by M. Laennec to a black, opake, preternatural production, which had already been described by several pathologists before him, and which has been considered by some authors as a variety of cancer (Meckel), or of tubercles (Broussais).

The melanotic substance occurs either in masses, which vary in number, volume, and form, or it is infiltrated into a great number of organs, and particularly into the lungs, in the cellular, the glandular, and muscular systems, on the surface of the serous and the mucous membranes, in the lymphatic ganglia, &c. When it occurs in masses, they are connected to the surrounding tissues by cellular substance, which is traversed by blood-vessels that do not

penetrate into the melanotic substance: this has no appearance of texture, and receives considerable firmness and tenacity from the membrane which envelops it. By its softening, which takes place in a very short time, the melanosis is converted into a blackish deliquescent substance, which, if it be not immediately discharged from the system, may be absorbed so as to colour the neighbouring solids and fluids. This softening does not influence the general health in so terrible a manner as that of the preceding productions.

The chemical analysis of the melanotic substance has shown that it is composed of a great quantity of the fibrin and colouring matter of the blood, a small quantity of albumen, a considerable proportion of phosphate of lime, of the oxide of iron, of the subcarbonate of soda, and of the chlorate of sodium.

Bibliography of Pathological Anatomy.

Besides the works cited above:

Morgagni. De sedibus et causis morborum.

Bonet. Sepulchretum, sive anat. pract. Genevæ, 1700.

Prost. La Médecine éclairée par l'ouverture des corps. Paris, an XII.

J. Cruveilhier. Essai sur l'anatomie pathologique en général et sur les transformations et productions organiques. Paris, 1816.

P. Rayer. Sommaire d'une Histoire de l'Anatomie pathologique. Paris, 1810.

Bayle. Sur les indurations blanches des organs; dans le Journal de Méd., tom. IX, an VIII.

—— Remarques sur les tubercules; Journal de Corvisart, tom. VI.

—— Recherches sur la phthisie pulmonaire. Paris, 1810.

Laennec. Journ. de Corvisart, tome IX.—Sur les mélanoses; dans Bull. de la Soc. de Médecine; 1806.—art. Anatomie pathol. et Encéphaloïde, du Dict. des Sciences

médicales.—Traité de l'auscultation médiate, 2 fol. édit. Paris, 1826.

Broussais. Histoire des phlegmasies chroniques, 4vo. édit. Paris, 1826.

Maunoir. Mémoire sur le Fongus hématode. Paris, 1820.

Breschet. Considérations sur une dégénérescence organique appelée dégénérescence noire. Paris, 1821.

——— Supplément aux Considérations sur la Mélanose; dans la Revue médicale, tom. VII, p. 79.

Andral fils. Clinique médicale. Paris, 1824—1826.

THE END.